THURSDAY, SEPTEMBER 25, 1919.

THE MISSING THEME.

Wild Life of the World: A Descriptive Survey of the Geographical Distribution of Animals. In three volumes. By R. Lydekker. Vol. i., pp. xiv+472; vol. ii., pp. xii+440; vol. iii., pp. xi+457. (London: F. Warne and Co., 1916.) Price 4*l.* 4*s.* three vols.

IT is doubtful whether any modern naturalist other than the late Mr. Richard Lydekker could have written such a book as this. Endowed with a remarkable memory, boundless energy, and a facile pen, he spent his days in acquiring a perfectly unrivalled knowledge of natural history and in writing about it. No matter what aspect presented itself for discussion, it found Lydekker and his pen both ready and willing. A friend in common, writing for a newspaper, once confessed to Lydekker that he had great difficulty in finding themes for his weekly articles. "Pooh! I find no difficulty," said Lydekker. "I do not require a *theme*—I think of a *word*." Using every possible moment and opportunity, and writing at incredible speed, Lydekker's literary output was enormous; it covered, moreover, the whole wide field between comparative anatomy, palæontology, and systematic work on one hand, and field natural history and sport on the other. While writing, at least, he was never filled with doubts or tormented by vain cares; whatever came into his head first he wrote, and what he wrote he printed light-heartedly as soon as possible. One scarcely likes to apply that harsh epithet "careless" to writing with so much good, solid work as its foundation, but the dangers of Lydekker's methods are obvious, and as a result one cannot place the normal degree of trust in any book that he wrote. Nevertheless, the fact that his books contain a huge store of real and valuable information is beyond all dispute and a testimony to the industry and genius of the author.

The three stately volumes now before us represent Lydekker's last effort. Well printed and beautifully illustrated, they appear unusually attractive. Opening them and reading at random, one is usually pleased and sometimes delighted with the text, and no doubt to many persons the book will be not only useful, but also a precious mine of information. Casual reading, however, is not the purpose of the book; it aims at being a descriptive survey of the geographical distribution of animals; but an attempt to read it as a whole proves to be a formidable and wearisome task, which one leaves sooner or later with a feeling of disappointment. From the title one expects a connected narrative in which there will be an attempt to expound, albeit in a popular manner, some of the principles underlying geographical distribution, to show how the present depends upon the past, and to bring home to the reader, however ignorant of zoology, the fundamental importance of such things as isolation—in its numerous forms—in the great scheme of evolution.

It would not matter at all what sort of view or theory the author developed in his narrative; he might have proceeded, with equal advantage, along the lines of his own "Geographical History of Mammals," or pursued the attractive, though totally divergent, courses of Scharff on one hand, or of Matthew on the other. Books with an endoskeleton are generally far better than those with a mere exo-skeleton. In one case the reader has something definite and more or less fascinating to follow; even when the writer's style is harsh and his phrasing none too happy, there is a plot which holds one fast while it gradually reveals itself in a well-connected stream of facts. In the other, the facts are disjointed and scattered—interesting and important in themselves, perhaps, but with little or no apparent bearing upon one another; in such a case the author may be endowed with superlative gifts of language and expression, enabling him to charm us on every page, perhaps, when taken in small doses, but he can never succeed in holding the attention of the reader from cover to cover. "Wild Life of the World" is in all essential respects a distinguished example of the books without endoskeletons. In this case, too, alas! Lydekker did not trouble to think of a theme—though he thought of a great many words.

The work calls for little more in the way of general criticism, but it may be worth while to direct attention to one or two specific matters. As an instance of the hasty selection of the facts dealt with, we may mention that, while more than two pages (vol. i., pp. 212–14) are devoted to a discussion of European field-mice (Microtus), no mention is made of the Orkney vole (*M. orcadensis*), which from the point of view of geographical distribution is one of the most interesting and important species; nevertheless, room is found for a whole paragraph dealing with the characters and habits of a phantom species, *M. campestris*, described from Brunswick long ago by Blasius, but generally admitted now for many years to be nothing more than a misidentification of the common Continental vole, *M. arvalis*.

In reading the book we have noticed few misprints. There is, however, an unfortunate transposition in the account of the cuckoo (vol. i., pp. 90–96) which may bewilder the reader. The matter from the word "moreover" in line 2 of p. 93 down to the end of the paragraph seems to be a misplaced continuation of paragraph 2 of p. 91, dealing with the colour and markings of the eggs. The name of the inventor of the harpoon-gun, Svend Foyn, has been converted into "Sven Foyle" (vol. iii., p. 310). It is with considerable satisfaction that we notice that Lydekker endorsed the view that whales and seals in southern latitudes are now in need of a measure of protection, and that our own Government has to bear the weight of direct responsibility in this matter. The quite indiscriminate and unscientific,

though lucrative, slaughter which is at present happening in the southern hemisphere and elsewhere is rapidly leading both the larger Cetacea and a valuable industry to extinction.

Lydekker's remark that the Addo Bush elephants "are specially protected" causes a pang when we recollect that the statement is no longer true. No naturalist could hear of the recent decision to exterminate this most interesting herd without grief. One may be pardoned for wondering whether much more would be heard either of the damage done by these elephants or of the project to exterminate them if the authorities, in granting the licence to kill, were to stipulate that the whole of the profits of the chase should be expended upon obtaining such a series of specimens, photographs, and casts as would form an adequate memorial of the threatened race for the use of zoologists and comparative anatomists, and that the balance, if any, should be applied for the purposes of zoological research in Africa.

To conclude, we would reiterate that this book contains a vast amount of most interesting and valuable information brought together by a man of unrivalled experience and ability; this information is most lucidly conveyed throughout, and many passages in the work are quite charming. The illustrations, on the whole, are very good, and some of the coloured plates may fairly be called magnificent. Our sole regret is that Mr. Lydekker did not require a theme.

M. A. C. H.

WATER IN ACTION—CONTROLLED AND FREE.

(1) *Irrigation Engineering.* By Dr. A. P. Davis and H. M. Wilson. Seventh edition, revised and enlarged. Pp. xxiii+640. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 21*s.* net.

(2) *Shore Processes and Shoreline Development.* By Prof. D. W. Johnson. Pp. xvii+584. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 23*s.* net.

(1) AFTER passing through six editions, this work, originally composed by Mr. Wilson in 1896, has been recast and largely rewritten with extensive additions by Dr. A. P. Davis, whose own book on "Irrigation Works in the United States" was reviewed in NATURE for June 20, 1918. It speaks much for the merits of a technical work that it should reach a seventh edition, and the present issue will undoubtedly maintain the reputation gained by its predecessors.

The scope of the treatise is wide—admittedly too wide for complete treatment—and the object kept in view, and that very successfully, has been to present a general outline of the whole field of irrigation work, including its history, the chemistry of soils and soil treatment, sources of water supply, methods of application and measurement, construction of canals and dams, drainage and sewage disposal, water rights, surveys and preliminary investigations, and systems of operation and maintenance. It is obvious that, even in a volume of 600 odd pages, matters so many and so varied could not be treated exhaustively, and that some must receive less attention than, perhaps, is their due. The chapter on masonry dams, for instance, would, in our opinion, have admitted with advantage of some amplification in respect of the fundamental law of the middle third, and some account of the theory of vertical shearing stresses, especially as the book is intended primarily as a manual for engineers.

On the other hand, there are to be found on nearly every page practical notes of considerable utility. Moreover, at the end of the volume is the complete specification, running to fifty-six pages of small print, of the contract for the construction of the Arrowrock dam in Idaho. This, in itself, will prove of inestimable value to the practising engineer for reference purposes. There are also a number of tables with useful data, and computed results of various formulæ.

Another restriction, which must be noted and, perhaps, is inevitable, is that, with one or two rare exceptions, all the examples illustrated are chosen from American practice. It is true that the Assuan dam is mentioned, and that Indian irrigation is not without notice, but the book is written almost entirely from the American point of view. Possibly it gains in interest and value in this way, since the authors thus confine themselves to cases in which they speak with experience and authority.

The illustrations, both photographs and diagrams, are excellent throughout. It is a most valuable and informative book, in a comprehensive way, on a subject which materially affects farmers, geologists, meteorologists, engineers, chemists, and business men, as well as the highest interests of the State.

(2) A work of some 550 pages, in which a list is given of 416 authorities cited, and the references in one chapter alone amount to 187, cannot fail to impress the reader with the erudition of its author and the immense labour he must have taken to collect his data. We pay a tribute, in passing, to the unremitting zeal and perseverance which have produced so concise a compendium of opinion on a subject which, on account of its complexity, is little understood and yet is of the greatest scientific interest.

The book is compiled on methodical lines. Each chapter opens with an "Advance Summary" and closes with a "Résumé." The first and second chapters deal with waves and their work, the third with currents, and the fourth with shore classification. The ensuing six chapters contain an exposition of theories of shoreline development.

The earlier part of the volume is largely historical and retrospective; it reviews the data obtained by experimentalists in the past, with the

conclusions based upon them. That there is a radical divergence of testimony is evident from the fact that by one school of thought coastal drift is attributed entirely to wave action, and by another to current flow. By the author no doubt is entertained that, as a whole, waves are the more important agency, and in this view of joint action we are disposed to concur.

In dealing with shorelines, the author rejects the German system of numerical notation, and classifies them broadly as submergent, emergent, neutral, and compound, with a cycle of development passing from young to mature and old. Each of the four classes is dealt with at length, and there are apposite examples, illustrated by photographs, charts, maps, and diagrams, which will repay study. Fjords are not recognised as an indication of land subsidence, but are attributed to glacial action, and it is interesting to note the author's opinion that "any careful analysis of the process of marine erosion must lead to the conclusion that marine planation is possible without coastal subsidence."

The book covers a fairly wide area, and is written with the intention of assisting the engineer, the geologist, and the geographer. As affecting the first-named profession, the difficulty of reconciling the conflicting views of so many eminent authorities seems to us almost insuperable. There is scarcely any problem which causes the harbour engineer more perplexity and anxiety than that of forecasting the effect on the shoreline of a structure projecting into the sea, and in the present state of our knowledge—or ignorance—the evidence available is often capable of quite contradictory interpretations. No doubt further investigation will throw more light on this baffling question, but, for the present, it is beset with obscurity.

The volume is an excellent addition to the literature of physiography, and it fulfils a special function in classifying much fragmentary and detached information not readily accessible.

BRYSSON CUNNINGHAM.

MAMMALIAN PHYSIOLOGY.

Mammalian Physiology: A Course of Practical Exercises. By Prof. C. S. Sherrington. Pp. xi+156+ix plates. (Oxford: At the Clarendon Press, 1919.) Price 12*s.* 6*d.* net.

THE publication of Prof. Sherrington's practical course of mammalian physiology will surely be recognised as an event of first-rate importance for the teaching of physiology and for medical education.

Many teachers must long have felt the limitation imposed by the use of the frog for practically all class-work on living animal organs. The experiments possible to students were restricted to certain aspects of the subject; some were liable to be retained in the course which had mainly historical interest, and others were apt, in unpractised hands, to degenerate into exercises in fine dissection. Nor had the technical facility thus acquired much relation to the later requirements of the medical equipment.

The introduction into class teaching of the surviving carcass of the decerebrated or decapitated cat effects a great liberation. The student can observe for himself the main phenomena of mammalian function. The technique is in most cases relatively so simple that attention is concentrated on the observation of the result; at the same time, it has real value as an introduction to surgical manipulations.

The course opens with exercises on isolated mammalian plain muscle—intestine, spleen, and artery—and on the perfused heart of the rabbit. They involve no very new departure, but the methods given require simple apparatus only, and are admirably adapted to give successful results in the hands of students. Here, too, as throughout the book, each exercise is given the maximum educational value by the explanatory and historical comments.

From Exercise IV. onwards the decerebrated or decapitated carcass is used. Starting with relatively simple experiments on the arterial blood-pressure, the course leads to more elaborate demonstrations of the effect of nerve-stimulation on the vascular mechanism and the activity of the respiratory centre, of vascular and somatic reflexes, and ultimately, when the requisite dexterity has been acquired, to such relatively exacting experiments as that on the stimulation of pancreatic secretion by secretin. In each exercise the opportunities are fully used for incidental observation of important phenomena, not directly connected with the main object of the experiment.

The student who conscientiously follows this course must emerge with a wealth of experience in the methods of physiological observation, and a vivid apprehension of vital phenomena, which no amount of reading or even of witnessing prepared demonstrations could give. Prof. Sherrington himself points out that the method leaves to the individual teacher a wide choice of valuable exercises, beyond the representative series which he has been able to accommodate within the limits of his course. He opens, indeed, a new vista of possibilities to student and teacher alike.

The value of the book is greatly enhanced by the admirably clear drawings of dissections and apparatus. The records reproduced, nearly all taken from experiments made in the class, give convincing evidence that the exercises are well within the compass of the keen student. The last exercise of all, that on the determination of the opsonic index, seems to lie curiously outside the general scope of the course, and to have no clear connection with the opportunities offered by the brainless mammal. Doubtless experience has shown that its inclusion has some special advantage.

Not only students and teachers, but also those engaged in original investigation, have abundant cause for gratitude to Prof. Sherrington for the care and labour which he has expended on putting his methods and experience at their disposal.

H. H. D.

OUR BOOKSHELF.

Birds Beneficial to Agriculture: Economic Series No. 9, British Museum (Natural History). By F. W. Frohawk. Pp. vi+47. (London: British Museum (Natural History), 1919.) Price 2*s*.

IT is important that attention should be focussed now and again on the benefits that accrue to farmer and gardener from the activities of birds, for too frequent reiteration of misdemeanours tends to produce an antagonism which the facts do not warrant; and there is greater danger in indiscriminate destruction than in indiscriminate protection. Recognising these facts, the Trustees of the British Museum have done good service, at once to the farmer and to the naturalist, in publishing this pamphlet, and in preparing the special exhibit to which it makes an efficient and attractive guide.

Of the birds the presence of which in Britain is of any importance in this connection, "120 species may be regarded as decidedly beneficial to agriculture generally," and of these Mr. Frohawk describes in detail a very fair sample of forty-four species, and adds besides two short general notices, necessarily somewhat perfunctory in treatment, on birds in their relation to injurious insects and to agriculture. Careful illustrations by the author make easy the task of identifying a large proportion of the species described. It is to be regretted, however, in a work dealing primarily with economic values that more space could not have been given to feeding habits and food statistics, even at the expense of specific characters and of habits of less immediate importance. Nevertheless, this latest addition to the "Economic Series" of British Museum Publications should help to awaken and broaden interest in the valuable heritage which Britain possesses in its birds.

Rudiments of Handicraft. By W. A. S. Benson. Pp. 40. (London: John Murray, 1919.) Price 1*s*. net.

THIS is a forty-page pamphlet, illustrated by fourteen pages of sketches, which attempts to set forth the principles and practice of manual training for children between the ages of eight and twelve, taking wood in the form of sawn laths $1\frac{1}{8}$ in. wide and $\frac{1}{4}$ in. thick as the material to be used.

The idea of the use of strip wood manipulated by quite simple tools is by no means new, having been adopted in certain important educational centres more than twenty years ago. It is difficult to realise how some of the exercises figured in the book can be made into the substantial structures for which they are designed on the methods described, and many of the drawings leave much to be desired from both the technical and artistic points of view. It is just as important for the pupil to be taught to make an accurate drawing in plan elevation and section of the object he purposes to produce as it is for him to execute it.

The well-trained manual instructor who ought to find an honoured place in every school will search in vain for much that is really helpful to him in the pamphlet. The principle of hand and eye training and of its high and necessary educational value is now fully admitted by educationists and is well established, and a large body of capable men fully trained in teaching methods are now available who have formed themselves into an association and assemble in annual conference with the view of promoting the efficiency of their work.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

National Representation upon International Councils.

IN the account of the meeting of the International Research Council (NATURE, August 14, p. 464) it is stated that "the United Kingdom" was "represented" on the council by "delegates." The explanation in the first paragraph of your Notes of September 4 of how the "delegates" were appointed shows that the words are the expression of an intention rather than of a fact. The council apparently wished that its decisions should have some authority other than that derived from the personal distinction of its members, but their wishes remained unfulfilled because there is in existence no machinery for selecting a delegation representative of the scientific workers of this country. It seems worth while, therefore, to inquire what characteristics such machinery must have in order that it should fulfil this purpose, and how such machinery could be set in action.

I suggest that the machinery necessary and sufficient would be such as secures that every professional scientific worker is informed of any action that it is proposed to take which may affect his work and that he has a constitutional means of expressing his opinion upon the proposal. It does not appear to be necessary that any attempt should be made to obtain the equality of voting power which is important in a representative body concerned with political and economic questions—so long, of course, as such questions are excluded from the domain of the body and its attention is confined to purely scientific matters.

The chief difficulty in establishing such machinery is that of defining the class of professional scientific workers. It ought to be overcome by the method used in defining the members of other professions. Lawyers, architects, actuaries, and medical practitioners are defined by membership of certain professional societies, of which the distinctive feature is that they admit to membership all who have undergone certain training and acquired certain experience. Societies having this feature already exist in the profession of science; the various scientific and engineering institutions and institutes are examples. They do not at present cover the whole field, but it will probably be agreed that it is desirable that they should. The best way of securing the representation of science would be to set up institutes for those branches of science which do not already possess

them; to organise a small permanent secretariat supported by them all; and to charge this secretariat with the duty of bringing before the institutes any scientific matters likely to interest them. It should be made clear that this secretariat should be the means of communication between the scientific profession of this country and all outside bodies (foreign scientific bodies, Governments, commercial organisations, and so on); to discuss the questions submitted to it, the institutes would appoint delegates appropriate to the nature of each question.

But it is always desirable, if possible, to use existing machinery for such a purpose. It is possible that such an organisation as is required might be developed out of the Conjoint Board of Scientific Societies. The societies represented on it do not all conform to the type of institutes; some are barely scientific; some have no professional test for membership; some of them overlap and represent practically identical interests. But it is probably better to have some machinery at once rather than a perfect machine which will take long to get into action; probably also the machine will improve as it works; its defects will be apparent, and there will be a demand for their cure. I venture, therefore, to suggest respectfully that, unless anybody has a better plan to propose, the Conjoint Board should consider early and earnestly whether they cannot take upon themselves, permanently and consistently, the functions of a body representative of scientific workers in all purely scientific matters.

Hitherto these functions, in so far as they have been exercised at all, have been exercised by the Royal Society. While it was held that the proper spokesmen for science were its most eminent students, no body could have been more suitable for selecting them than that which annually selects for the coveted distinction of its membership the fifteen most eminent men of science still outside its ranks. (For it is obvious that no woman could be included in that number.) But if the spokesmen are to be representative delegates, no body could be less suitable. If the character of the society is to be maintained, exclusiveness must be as essential a part of its constitution as inclusiveness must be of any representative body. By its very nature the Royal Society can never represent any but a small fraction of scientific workers; it cannot represent the fraction which, because its work lies in the future rather than in the past, is most likely to be affected by any proposals for change. We all thank the society for what it has done; we can express our gratitude best by liberating its energies for those more important tasks for which its constitution is adapted.

NORMAN R. CAMPBELL.

Kettlewell, September 20.

Intravenous Injections of Gum Solutions in Cholera.

IN NATURE for June 5 Prof. Bayliss advocates, with good reason, in view of his valuable work on gum solutions in shock, that a trial should be made of their intravenous injection in cholera with a view to obtain a more prolonged maintenance of the blood-pressure than sometimes follows the use of hypertonic salines. Last year Prof. Bayliss kindly sent me a copy of his paper on gum solutions in shock, and in acknowledging it I informed him that I had previously read it, and been so struck with the possibilities of the method being of great value in the very severe cases of cholera which repeatedly collapse, and are sometimes lost in spite of hypertonic salines, that I had lost no time in trying it, but, unfortunately, with very disappointing results. This letter apparently did not reach Prof. Bayliss, probably on account of "enemy action."

With one exception, the cases in which I tried the gum solution were rather below the average severity, as is commonly the case in the rainy season, when the trial took place; yet several were lost which I should have expected to have recovered under hypertonic salines Still more striking was the fact that, instead of the great relief, often resulting in sleep before the hypertonic saline injection is finished, the gum solutions were followed by increasing distress, difficulty of breathing, and cyanosis, which soon compelled me to abandon their use. In view of the shortness of my trial, I decided not to publish my results at once, in the hope that others might be more successful, but I have now learned that my friend, Lt.-Col. A. Leventon, I.M.S., has extensively tried gum solutions in accordance with Prof. Bayliss's method at the Campbell Medical School Hospital, Calcutta, where well over one thousand cases have been treated in the first half of this year, and Lt.-Col. Leventon has authorised me to state that, with various strengths of the purest gum arabic up to 7 per cent., his results have been in entire agreement with mine, and he has also had to abandon the method. He, too, noted the same distress and cyanosis which I saw, and the unexpected loss of not very serious cases under the treatment—clearly indicating that gum solutions do not meet the physiological needs of cholera cases.

I confess that this failure has been a great disappointment to me, but I believe the explanation to be that the gum solutions lead to the retention in the circulation of the deadly cholera toxins, which are absorbed from the bowel in increasing quantities with the restoration of the circulation by intravenous injections of large quantities of salt solution, with or without gum, but which are usually sufficiently rapidly re-excreted through the kidneys and bowels after hypertonic saline to avoid dangerous accumulation in the blood. The fact that I found salines made up with freshly distilled water produced febrile reactions, indicating that the fever was due to toxin absorption, lends support to this view. There is still room for considerable improvement in the treatment of the most severe toxic cases of cholera, but the hopes which Prof. Bayliss's researches in shock led me to expect from gum solutions in cholera have been disappointed. I have for long thought that the most promising line of advance is the use of anticholeraic serums, such as those formerly made by Salimbeni in Paris and Schurupow in Russia, but which I have not yet been able to obtain facilities for making in Calcutta owing to the war. Perhaps one of the hill laboratories of India could take up this important line of work, and send the serum to be tested in Calcutta, in addition to my system of treating cholera.

LEONARD ROGERS.

I BEG to thank you for your courtesy in permitting me to see the above communication from Sir Leonard Rogers. It is unfortunate that the letter to which he refers did not reach me, because it is evident that the effect of gum saline in states similar to that of cholera requires investigation. If the cases to which reference is made had been very severe, one might have supposed that an excessive viscosity was conferred on the blood by the addition of gum. I have made some experiments on this point, but have been unable to detect any serious result when gum saline has been injected after the blood has been concentrated by various means.

It is possible that the retention of toxins may be the explanation, and, of course, the object of any

simple intravenous injection is merely to keep up a normal circulation until the remedial agents, such as the specific sera to which Sir Leonard Rogers refers, may be able to produce their effect. The symptoms mentioned, however, suggest to my mind rather some mechanical action of the gum, and it might perhaps be worth making a trial of a preliminary saline injection, followed later by one of gum saline, to avoid too rapid a loss of the fluid injected. In any case, I hope that the experiments now in hand may throw further light on the problem and lead to a means of avoiding the serious disadvantage. I may mention that in my experiments gum saline was found very effective in restoring the renal secretion, and I am convinced that if it should be found possible to use such solutions they would be more permanent in their results and lead to the more rapid elimination of the toxins, if this takes place through the kidney.

W. M. BAYLISS.

A Photoelectric Theory of Colour Vision.

READING in the *Irish Times* of to-day (September 11) a very brief reference to a paper communicated by Sir Oliver Lodge to the British Association, in which Sir Oliver suggests that light absorbed in the black pigment may stimulate certain atoms into radioactivity and so cause the sensation of light, I am reminded of a theory of colour vision which I endeavoured to investigate some years ago. The theory is that the emission of electrons, probably by the pigment layer under light stimulus, is responsible for light-sensation, and that where these electrons act upon the cones they excite colour vision. It is known that, in the photo-electric expulsion of electrons by light, the range of the electron increases with the frequency. Hence for violet light the cone would experience a different distribution of the stimulus from that for red light, and so on.

I endeavoured to detect a photoelectric effect by experiments of the usual sort, using a bullock's eye in which the pigment layer had been exposed. Although a fairly sensitive arrangement was ultimately arrived at, I failed to detect the sought-for effect. I put the matter aside, although urged by some physiologists to continue it.

That the photographic image is initiated in a somewhat similar manner seems very probable. On this view much has already been written. J. JOLY.

Trinity College, September 11.

Mathematics at the University of Strasbourg.

I HAVE received the programme of the courses in mathematics at Strasbourg, which will undoubtedly stand second only to Paris among the French universities. The Institut de Mathématiques, which forms part of the Faculté des Sciences, is to have five titular professors and three "maîtres de conférences," and offers complete graduate and post-graduate courses. The professor of *analyse supérieure* and director of the Institut is M. Maurice Fréchet. MM. Valiron, Villat, and Esclangon occupy respectively the chairs of calculus, rational mechanics, and astronomy; the chair of geometry has not yet been filled.

While English mathematicians are fully appreciative of the work of their French *confrères*, the French universities, where students of the other nations of the world have flocked, have in the past been a little neglected by English mathematical students. An English student could not do better than spend one of his post-graduate years in France, where he will find every facility and encouragement, and a very warm welcome. H. BRYON HEYWOOD.

The Magnetic Storm of August 11–12, 1919.

I OBSERVE in the issue of NATURE for August 21 an account of the magnetic storm of August 11–12, 1919, by Father Cortie, of Stonyhurst College Observatory, and note that he looked out for a possible display of aurora on the night of August 11. "But," he says, "the brightness of the moon effectually veiled any such appearance, even if it were present."

In these circumstances it may be well to record that a fine display of the Aurora Borealis was observed here, Cape Breton Island, Nova Scotia, on the night of August 11. The affected area extended far into the southern sky. Pulsations of light swept upwards to the zenith, resembling clouds driven before a heavy wind. ALEXANDER GRAHAM BELL.

Beinn Bhreagh, near Baddeck, N.S.
September 5.

THE WATT CENTENARY CELEBRATIONS.

THE Watt Centenary Celebrations in Birmingham last week were full of interest, and the presence of representatives from the United States of America, Australia, France, Japan, and Sweden, as well as a cordial message from Norway, bore testimony to the honour in which the memory of James Watt is held throughout the world. At the inaugural meeting on Tuesday, September 16, the Lord Mayor (Sir David Brooks), in welcoming the visitors (among whom were Mrs. Gibson Watt and Miss Boulton, direct descendants of James Watt and Matthew Boulton), said that it was fitting that Birmingham should wish to establish a permanent memorial to the man whose discoveries and inventions had done so much for the city of his adoption. He thought that the proposals as to the form which the memorial should take would commend themselves not only to Birmingham citizens, but to all who really appreciated the work which James Watt and his associates had accomplished. It was proposed to endow a "James Watt Chair of Engineering" at the University of Birmingham, for the prosecution of research in the fundamental principles underlying the production of power. He hoped that the success of this part of the scheme would early be placed beyond doubt. In addition to this it was very desirable to have in the city a suitable building to house examples of the work of Watt, Boulton, and Murdock, and the relics which these men had left behind—a building which might also be a suitable meeting place for scientific and technical societies.

An address on "The Rise of Engineering Manufacture" was then delivered by Prof. F. W. Burstall (professor of mechanical engineering in the University of Birmingham). Before the middle of the eighteenth century a high degree of skill in metal work had been attained, but lack of power restricted the scale on which work could be done. Prof. Burstall directed attention to the fact that Boulton and Watt were looked upon as the first builders of steam engines, but their work in starting a system of co-ordinated manufacture had generally been overlooked. He believed that both the conditions of work and the quality of the workmen to-day were considerably in advance of

those of one hundred years ago. There was no likelihood that the highly-skilled worker would ever be replaced by a machine, but for the vast number of unskilled workers machinery meant monotonous work. For the latter the provision of means of healthy recreation was of vital importance.

Then followed a lecture by Prof. Hele-Shaw on "James Watt and Invention." The lecturer emphasised the importance of inventions, and remarked that in the late war the country was many times saved by our own inventions, which were brought into being under the stimulus of patriotism and the encouragement given by timely organisation. He made the suggestion that, as Watt was so pre-eminent as an inventor, the proposed James Watt chair should be a chair of invention instead of one of engineering. Such a chair would be unique and worthy of James Watt as a new and original departure.

In the afternoon an impressive memorial service was held at Handsworth Parish Church, where Watt and his associates worshipped and were buried. Adjoining the church is the memorial chapel in which stands the famous Chantrey statue of James Watt, and there, after the singing of the anthem "Let us now praise famous men," the Lord Mayor of Birmingham laid a laurel wreath at the foot of this statue. The address was delivered by the Rev. Dr. E. W. Barnes, Canon of Westminster, who claimed that "it was especially fitting that Birmingham should honour James Watt, for it was there that he perfected his steam-engine; there he found workmen of sufficient skill to carry out his designs; there he found in Boulton the friendly capitalist of whom he was in need; there his fortune was made; and there he died in honourable old age. Throughout his life Watt was a religious man. He had not the temper or interests of a theological partisan. His attitude was that of a philosopher, conscious of the complexities of social organisation and of the inherent difficulties of government—a man of science, fully understanding how immense were the distances that shut us in, and not unconscious of the danger of unduly dogmatic speculation as to the unknown." Dr. Barnes compared the good and evil resulting from Watt's genius: "We were, owing to Watt's inventions, using up coal at a dangerously rapid rate, and when it was gone the industry and the workers which the coal sustained must pass to other lands. The desire for more motion and for barren luxuries had crowded life and wasted toil, taking largely from man's mental freedom and physical rest. And of all barren luxuries by which man wasted Watt's legacy the worst was war. We could thank God sincerely for Watt's discoveries and the mechanical revolution to which they led, if we remembered that it was the political sagacity and moral wisdom of men that had been at fault. In the last century mechanical progress so outstripped spiritual growth that disaster resulted. In default of security gained by religious idealism, the better men and the best races would be eliminated by war, and we should be left with moral degenerates, clever, indeed, in the invention and control of machines, but destitute, and even contemptuous, of spiritual energy."

After the service the visitors were entertained at a garden party at Heathfield Hall by Mr. George Tangye, and much interest was shown in Watt's famous garret-workshop, which has been preserved in the condition in which he left it a century ago.

On Wednesday morning, September 17, the proceedings were presided over by the United States Ambassador (the Hon. J. W. Davies), and an address was given by Sir Oliver Lodge on "Sources of Energy." The lecturer, in his most attractive and vigorous style, dealt mainly with the possibilities of intra-atomic energy. The stock of energy of this kind is prodigious, but it is at present almost entirely inaccessible, and the lecturer speculated on the possibilities of its use in the future.

This was followed by Prof. J. D. Cormack, Regius Professor of Engineering in the University of Glasgow, with a paper (written in collaboration with Prof. Barr) on "The Model of the Newcomen Engine repaired by James Watt."

In the afternoon, visits were paid to some James Watt engines, one at Ocker Hill being shown in action. Here Watt's original indicator was seen at work, and indicator-diagrams taken on it were distributed among the visitors. The occasion was one of unique interest, vividly impressing the mind with the genius of the great engineer, and at the same time bringing home the vast developments which a century has seen in the applications of steam-power.

In the evening about 300 guests assembled for the centenary dinner at the Grand Hotel, the Lord Mayor presiding, and the American Ambassador and the Chancellor of the Exchequer being prominent in a gathering of distinguished men. In proposing the toast of the "Houses of Parliament," Sir Oliver Lodge insisted on the vital need of the encouragement of scientific research, not by an *ad hoc* bureau in London, but through the universities throughout the country. He coupled with the toast the name of the Chancellor of the Exchequer. "They in Birmingham had an affection for Mr. Austen Chamberlain, and they in the University of Birmingham regarded him with affection because when he last held his present office he increased to them a Government grant which subsequent occupants of the office had followed up. It would be wisdom for this country to lavish money upon the universities. Economy was necessary, but it did not pay to cut off the best part of the money granted to the universities."

Mr. Austen Chamberlain, in replying, spoke of the difficulties of a Chancellor of the Exchequer, especially at the present crisis; but he was sympathetic. University education was one of the things that seemed to him to require generous

treatment, and he had endeavoured to ensure that university grants should be increased—not merely by a temporary increase which was given to repair the injury done by the war, but by a permanent increase. That expenditure would grow as they could afford it, but they must not expect the Government to move too far. People might be enthusiastic men of science and devoted sons of universities on Monday, but on Tuesday, when he presented the budget, they were taxpayers. ". . . The Government would do its share on one condition only—that the towns did their share also."

The toast of "The Navy, Army, and Air Force," proposed by Mr. Gilbert C. Vyle, was replied to by Admiral Sir G. G. Goodwin, who acknowledged the debt of the Navy to Watt, and by Colonel Barraclough (professor of engineering in Sydney University), the latter expressing the opinion that "if the agitator, the profiteer, the man who was inclined to relax his labours, could all come to Soho and live, as the visitors to that commemoration had done, with the memories of Watt and his co-workers, they would go away with a higher sense of their responsibilities to themselves and to the community of which they formed a part."

The American Ambassador proposed the toast of "The City of Birmingham" in an admirable speech, in the course of which he said that one date in the summary of the important events in the life of James Watt was that of the American Revolution. "The ideas that the revolution embodied had not lost their force. But, great as that revolution was, and important as Americans believed the date to be, he was reminded that it was the year of an even greater revolution—the year when James Watt made his invention a practical success."

The toast of "The Memory of James Watt" was proposed by Prof. Burstall, who emphasised the value to James Watt of the strength and co-operation of Boulton.

Prof. Rateau brought "a tribute of honour and appreciation from science and labour in France to the memory of the great man in whose honour they were met that day."

On Thursday, at a special degree congregation, honorary degrees were conferred by the University on the American Ambassador, M. Auguste Rateau, Prof. Archibald Barr, Sir George Beilby, Colonel Blackett, Engineer Vice-Admiral Sir George Goodwin, and Mr. F. W. Lanchester. It was much regretted that Sir Charles Parsons was unable to be present.

On Saturday representatives of the Chamber of Commerce, the University, and engineering workers in Birmingham formed an impressive procession headed by a model of a James Watt engine. The interest taken by the workers themselves in the memory of Watt is perhaps the most encouraging feature of the commemoration, for the future depends very largely on the attitude of organised labour, and there is no doubt that many of the leaders of labour take an enlightened view of the educational needs of the country.

PROF. J. W. H. TRAIL, F.R.S.

WE regret to record the death on September 18 of Prof. Trail, who for forty-two years held the Regius chair of botany in the University of Aberdeen. Carrying his sixty-eight years with uncommon vigour, he lectured twice daily to the overcrowded classes of the past summer, and he seemed in July to be in the enjoyment of his usual health, so that it was with a shock that his friends heard of a serious operation. At first he rallied, but then rapidly sank. Those who knew him could hardly imagine for him any other end than that he should thus die in harness.

Prof. Trail was a marked figure in Aberdeen. Orcadian by birth, he was the son of Dr. S. Trail, professor of systematic theology in Aberdeen, and moderator of the General Assembly in 1874. He graduated with highest honours in natural science in 1876, and took his M.D. in 1879. In 1873–75 he travelled in Northern Brazil as naturalist to an exploring expedition, and used this opportunity for making a special study of Palms, of which family he had an expert knowledge. His results were published in a series of papers "On the Palms of the Amazon Valley," contributed to the *Journal of Botany*. On his return at the age of twenty-six he was appointed to the chair of botany in succession to Dr. Dickie. He held that post till his death.

Prof. Trail's work was marked by extreme accuracy, and guided by a keen sense of duty. Once a specimen was collected, he felt the obligation to make the most of it. The result of such work, extending over so long a period, has been the amassing of an enormous record of facts relating especially to the native flora. The *Scottish Naturalist* was one of the chief channels of his publication. There he produced a series of papers on Scottish galls and on leaf-diseases, which will provide rich material for those who follow. His mind was attracted by fact rather than by theoretical construction. His knowledge of those details which he studied was singularly wide and exact. For instance, having noted the inconstancy of floral construction in *Polygonum aviculare*, he monographed a single plant, and found as many as 120 distinct variations in number and relation of the floral parts borne upon it. He was rather reluctant in publication, but he was most generous in imparting his knowledge by correspondence, thus suggesting the stores that lay behind. These were most readily revealed to the botanical visitor to his house.

Prof. Trail was thoroughly typical of Aberdeen, vigorous, self-reliant, with a strong sense of duty, and a touch of austerity in its performance. Brought up in the granite city, he took a large hand in the guidance of education there. Not only was he a leader in the University itself, but he also took part locally in directing that secondary education which forms the natural foundation for the higher learning. Himself son of a professor and moderator, he married a daughter of the late

Prof. Milligan, who was also moderator of the General Assembly, and clerk of senate in Aberdeen, and he leaves a son and three daughters. Thus truly the spirit of Aberdeen University was bred in his bones, and inspired him throughout his life. F. O. B.

NOTES.

SIR RICHARD GLAZEBROOK's appointment as Director of the National Physical Laboratory expired on September 17 on his attaining the age of sixty-five. Sir Richard had held the post with distinction for twenty years, having been appointed on the foundation of the laboratory by the Royal Society in 1899. For the first two years the work of the laboratory was carried out at Kew Observatory by the staff of the observatory with the addition of three scientific assistants. The income was approximately 5000*l.* per annum. Soon afterwards Bushy House became the home of the laboratory, and as its work extended additional buildings were erected in the grounds. At the present time these buildings probably provide a space twenty times that of Bushy House, and the staff now numbers about five hundred, nearly two hundred of whom are women. The ordinary expenditure of the laboratory just before the war was about 40,000*l.* per annum. During the war it rose to 110,000*l.* per annum. The rapid growth of the institution is the best proof that it met a real need, and that it met it efficiently. It owes its success to the administrative powers of the director and to the skill he exercised in his choice of the men to fill the earlier appointments. Without exception, these men have distinguished themselves by their scientific work and have contributed largely to the reputation the laboratory now enjoys. Eighteen months ago the laboratory was taken over by the Department of Scientific and Industrial Research, and, according to the report of that Department for 1918–19 just issued, 154,000*l.* is allocated to it for the current financial year. Although the laboratory does not attain its majority under Sir Richard's directorship, he has had the satisfaction of rearing it to a vigorous manhood, and he will from his Cambridge home watch its growth under Government auspices with interest. He is succeeded by Dr. J. E. Petavel, professor of engineering in the Victoria University of Manchester.

CIRCULAR No. 39, dated September 1, issued by the Meteorological Office, mentions the retirement of Rear-Admiral Sir John F. Parry and the appointment of Rear-Admiral F. C. Learmonth, C.B., who succeeds as Hydrographer of the Navy, and consequently as an *ex-officio* member of the Meteorological Committee. A conference of meteorologists will be held in Paris on September 30 and subsequent days, following the conference in London of the meteorologists of the British Dominions from September 23 to 27. A note is given relative to the time of occurrence of minimum air-temperature on the grass. The observations at Cahirciveen have been handled to test a suggestion made that the grass minimum for the night is frequently reached between sunset and 21h. Since April 1, 1917, the grass minimum at Valencia has been set at 18h., and read daily without disturbance at 21h. Out of 850 observations made to June, 1919, the number of occasions on which the phenomenon was observed was 101, which seems to be accounted for by a cloudy to overcast sky setting in during the evening, followed by rain, mist, or drizzle, with a wind of moderate force having a southerly component, the sky previously, between 18h. and 21h., being comparatively clear. The effect of terrestrial radiation is clearly to be traced in the foregoing explanation.

FROM the September issue the *Technical Supplement to the Review of the Foreign Press*, formerly issued by the General Staff of the War Office, is to be known as the *Technical Review*. With the same organisation and staff it will continue to provide a digest of the technical Press of the whole world for the benefit of engineers and manufacturers. At present the articles in it consist either of abstracts or of titles, with occasional short accounts arranged under the heads:—Engineering construction and transportation, mechanical engineering, mining and metals, shipbuilding and marine engineering, electrical engineering, aeronautics, chemical engineering and industry, miscellaneous, recent publications, and engineering index. The review provides for engineering in general the information as to recent progress which has been available for electrical engineering for some years in *Science Abstracts*, and for chemical engineering in *Chemical Abstracts*, as well as in the abstracts published by the Chemical Society and the Society of Chemical Industry.

AN important collection of Lycænidæ and Hesperidæ has recently come into the possession of Mr. J. J. Joicey, and is now at the Hill Museum, Witley. This collection was made by Mr. Hamilton H. Druce, who is well known as one of our greatest authorities on the Lycænidæ and Hesperidæ. A great many types of species described by Mr. Druce, as well as many of the types of Semper, are contained in the collection. Entomologists desirous of comparing any specimens in this collection are invited to write to the Curator, the Hill Museum, Witley, Surrey.

THROUGH the courtesy of the Corporation of London, a series of fortnightly lectures on industrial problems will be delivered at the Guildhall at 4.30 p.m., commencing on October 7. The speakers will include Mr. E. J. P. Benn, Prof. Ripper, Dr. Russell Wells, the Right Hon. Sir Auckland Geddes, Sir George Paish, and the Right Hon. Lord Emmott. Tickets for this series can be had on application to the Secretary, Industrial League and Council, 66 Victoria Street, S.W.1.

THE New York correspondent of the *Daily Mail* announces that, on September 18, Mr. Roland Rohlfs reached an altitude of 34,610 ft. in seventy-eight minutes in a 400-h.p. Curtiss triplane. The flight was observed by officials of the Aero Club, who sealed Mr. Rohlfs's instruments, and, when he landed, sent them to Washington for verification. The previous record for altitude was that of 30,500 ft. attained by Capt. Lang and Lieut. Blowes in January last. (See NATURE, January 9, p. 369.)

IT was announced by Sir Robert Hadfield at the autumn meeting of the Iron and Steel Institute, which opened on September 18, that the Prince of Wales had consented to become an honorary member of the institute. Dr. Federico Giolitti, formerly professor of metallurgical chemistry and metallography at Turin, was presented with the Bessemer medal for 1919 in recognition of his services to the science of metallurgy.

A LARGE neolithic graveyard, of the La Tène period, has been found by Dr. B. Schnittger at Gestilren, in Vestrogothia. Two quadrangular and ten circular stone enclosures were set on a gravel esker and covered by smooth slabs. The bones were burned, and in hollows or urns. Similar graves are known at Halleby and other places in Ostrogothia, but these are the first discovered in Vestrogothia.

THE Scandinavian Association for a Tropical Biological Station has decided to send an expedition this autumn to select a site for a research station to study marine biology. Dr. Th. Mortensen, who is chairman and founder of the association, will lead a small party including probably Dr. Nils Holmgren and a botanist. They will visit Celebes, North Borneo, Amboina, and New Guinea.

PROF. G. T. MORGAN will deliver the Streatfeild memorial lecture at the Finsbury Technical College at four o'clock on Thursday, October 2, taking as his subject "Applied Chemistry in Relation to University Training." Admission will be free.

IN the *Canadian Field-Naturalist* (vol. xxxiii., No. 2, May, 1919), Mr. F. W. Waugh, of the Geological Survey, Ottawa, gives a careful account of Canadian aboriginal canoes. The types of these are found in separate regions—the Eskimo kayak and umiak in the north, and to the south that of the birch-bark canoe. The latter apparently reached its perfection in the Algonquian area, a region extending from round the Great Lakes and some distance westward, to the maritime provinces and the New England States. This distribution was largely determined by the range of the canoe birch (*Vetura papyrifera*), which extends practically from the Atlantic coast to the Rockies. The disappearance of the birch southward is indicated by the inferior canoes of elm, buttonwood, and basswood bark built by the Iroquois of Central New York State. This latter type was heavy, inconvenient for portaging, and usually short-lived. Practically everywhere within the region of Algonquian influence proper the birch-bark canoe was essentially the same, such differences as occur concerning mostly the shape of bow and stern, which has evidently been derived almost exclusively from a single pattern, with local variations in the amount of curvature or recurvature, and the method of decking over at the ends, where such a device was employed.

PROF. CHILTON has published some notes of interest on destructive boring crustacea in New Zealand (*N.Z. Journ. Sci. and Techn.*, vol. ii., no. 1). The well-known European *Chelura terebrans* (an amphipod) and *Limnoria lignorum* (the "gribble," an isopod) are active destroyers of pier-timber in the southern seas, and the latter devours also the insulating material of submarine telegraph cables. In addition, an Australian isopod, *Sphaeroma quoyana*, burrows into sandstone rock as well as into timber.

IN the Annals of the Natal Museum (vol. iv., pt. 1), among several interesting zoological papers, one on the wing venation and respiratory system of certain South African termites by Claude Fuller is worthy of special notice. Details are given of the relation between wing nervures and primitive air tubes in several genera of termites, and the student of insect transformations may obtain much instruction from Mr. Fuller's demonstration of the development and unfolding of the wings from the larval and nymphal rudiments.

DR. VICTOR E. SHELFORD writes in the *Scientific Monthly* of August last on the general question of the waste involved in the discharge of domestic and industrial sewage into the sea and rivers. Experimental methods for testing the effect on fishes of various substances in solution have been devised. The reaction employed was the turning away of various kinds of fish from the part of a large tank where the contents of the water in the toxic substance was above or below the normal amount. The sensibility of fish to such compounds as occur in waste material is thus shown to be greater than has hitherto been supposed, thus an increase in carbon dioxide of 2 c.c. in one litre above the normal caused the turning-away reaction. A low oxygen content was also detrimental, and this was usually found to accompany a high carbon dioxide content. The waste substances resulting from gas-production works and from munitions processes were also studied, and it was shown that these substances, though almost insoluble, had very marked effects on fish-life. References to papers published by the author and his colleagues are given.

VOL. xxv. of the "Rapports et Procès-Verbaux" issued by the International Council for the Exploration of the Sea deals with the administration for the years 1916–18. The usual financial contributions were made by the neutral countries, Denmark, Holland, Norway, and Sweden, and by Great Britain for the years 1916–17 and for 1918–19. Some fishery investigations were carried on in Scandinavian waters, and a hydrographical bulletin summarising the results so far obtained is being prepared. The influence of the war on the fish population of the North Sea is discussed, and the opinion expressed that the stock of certain kinds of fish is undergoing considerable changes. "It is even within the bounds of possibility that the previous indications of 'over-fishing' may be replaced by indications of 'over-population' of fish." The testing of such opinions is regarded as a matter of much importance. "New points of view even as to restrictive laws may be expected as a result of such investigations." There is, however, no indication that such work is being seriously undertaken, and the "accumulated stock," if it exists, must soon be seriously diminished by the intensive trawling which may be expected very soon.

A DETAILED report on fruit culture in Malaya by J. N. Milsum (Bull. Dept. Agr., Fed. Malay States, No. 29, Kuala Lumpur, 1919) has recently appeared. The story that is told here or written between the lines might be told of most countries of the eastern tropics, or, indeed, of most countries where the population that is likely to consume such fruit is small and migratory. The native of the country is content with the fruit that is easily produced there and already well known (in this case the durian, mango, sapodilla, mangosteen, jak, etc.), and has no desire for others. The migratory European planter does not think it worth his while to grow fruit that he may not remain to consume. And, lastly, and most important of all, the profits of the established industries (here largely rubber) are greater and more certain than those of fruit culture, so that no one is tempted to grow fruit commercially. The result is that the resident in the country is reduced in general to bananas, pineapples, mangoes, and a few more, and these usually not of the best quality. What is really required, and shows real possibilities, is the improvement of those fruits that are already cultivated rather than the introduction of new ones. The resident, too, must be prepared to pay a good price for a good article. A detailed account is given of many different fruits and how to cultivate them, but little attempt is made to discriminate between really first-class fruits, such as banana, mango, or pineapple, and inferior fruits such as rambutan or rose-apple—interesting fruit to taste once in a while, but not fruit that anyone is likely to wish to cultivate.

THE Memoirs of the Indian Museum (vol. vii., No. 2, July, 1919) contains an interesting paper entitled "Observations on the Shells of the Family Doliidæ," by E. W. Vredenburg. The memoir is

illustrated by seven excellent plates reproduced from photographs, in which the features of four of the principal species of Dolium are well shown. The material dealt with is largely contained in the Indian Museum, and includes several species of Dolium and of Pirula. A very welcome and important feature is a review of the fossil occurrences of species belonging to these two genera, from which it appears that the genus Dolium is not known in formations older than the Oligocene, the greater number of fossil representatives being Upper Miocene and Pliocene; it seems to have reached the climax of its development at the present day. The genus Pirula, on the other hand, is known from Cretaceous times, and the fossil species are more numerous than the recent ones. In discussing the synonymy of certain of the species of Dolium, the author brings forward some excellent arguments in favour of the selection of specific names of long-established usage and tradition instead of the adoption of names which, though earlier, are not always to be trusted; for, as the author points out, there is always the risk of an industrious bibliographer discovering some forgotten monograph of earlier date than the one relied upon as final. This is only one of many cases, both of generic and specific names, which can be cited to show that a rigid application of the law of priority is not always to the benefit of science. As has been pointed out by others, it is for the International Zoological Congress to consider the adoption of a list of *nomina conservanda*.

CANADA and the Colonies of Bermuda and Newfoundland issue regularly a "Monthly record of meteorological observations" under the directorship of Sir Frederic Stupart. The record for March has just reached us, and it contains a mass of means for barometer, temperature, relative humidity, precipitation, wind direction and velocity, and cloudiness. For chosen stations the hourly readings are given which allow of minute examination of the climate. The detailed observations are "boiled down" to give a general synopsis of temperature and precipitation for the several districts and provinces. It is stated that under ideal conditions the means should be derived from stations uniformly distributed, but such ideal conditions are not only wanting in Canada, and it is a common failing elsewhere, if not everywhere. Maps are given showing difference of temperature from average, and total precipitation in inches. The temperature-map shows a deficiency of 14° F. around Alberta and an excess of 6° to the south of Hudson Bay. The precipitation is indicated by degrees of shading, the heavier falls being well shown over the parts bordering the Pacific and the Atlantic Oceans.

A MORE than usually interesting discussion of a typhoon in the Eastern seas by the Rev. José Coronas, S.J., the chief of the Meteorological Division of the Weather Bureau of the Philippine Islands, has been recently issued. The storm is called the "Quantico" typhoon, as it caused the total wreck of a large steamer of that name on the northern shore of Tablas Island. The storm is also known as "the Christmas typhoon of 1918," as it occurred on Christmas Day. The typhoon is carefully tracked throughout its course and maps are given at frequent intervals. Detailed observations are also given of the movement of the barometer and the direction and force of the wind. Several plates are given showing the damage caused by the typhoon. The track of the typhoon is said to be altogether abnormal, and this is probably the most interesting feature, as it contains a warning for both the seaman and the forecaster. The typhoon is shown to have first moved towards the west by north, then to have inclined northwards whilst to the east of the central part of the Philippines, and finally recurving backward not only to west by north, but to west by south, and even to west-south-west. The slow movement of the typhoon on December 23–24 is said, in 99 per cent. of the cases, to be a sign that the typhoon was recurving north-eastward, especially at the end of December, and to the east of the Philippines. Observations, however, prove most conclusively that the movement was in the opposite direction. The rate of progress of the typhoon was at first about 11 miles an hour, the rate afterwards decreasing to 4 miles an hour or less, whilst after recurving to the west-south-west the typhoon attained its former rate of progress. The vortical calm was probably 15–25 miles in diameter. The area of destruction whilst it was raging in or near Luzon was about 80–100 miles in diameter.

THE "Algebraic Cube" is a model illustrating the formula $(a+b)^3=a^3+3a^2b+3ab^2+b^3$. Imagine a cube of edge equal to $a+b$ cut by three mutually perpendicular planes each distant a from one of the sides. The eight pieces into which the cube is divided will consist of a cube of edge equal to a, a cube of edge equal to b, three blocks of base a^2 and height b, and three blocks of base b^2 and height a. Thus each piece represents a single algebraic term, which is engraved on the face of the block. The block a^3 is coloured blue, the three blocks a^2b are yellow, the three blocks ab^2 red, and the cube b^3 black. The model is the three-dimensional analogue of the well-known Euclidean construction showing the relation $(a+b)^2=a^2+2ab+b^2$, and should prove a very useful aid in teaching young pupils the foundation of the rule for the extraction of cube roots. The blocks are supplied in a neat cubical box, 10 cm. to the edge, by Messrs. Barnes and Morris, Ltd., scientific instrument makers, Audrey House, Ely Place, London, E.C.1.

WE learn from the *British Journal of Photography* of September 12 that Mr. Herbert A. Lubs, of the colour laboratory of the United States Bureau of Chemistry, has investigated the preparation of *p*-aminocarvacrol and its use as a developing agent in photography. It is conveniently prepared from carvacrol by the production of nitrosocarvacrol, and the reduction of this by ammonium sulphide. Five grams of the pure derivative were obtained from 10 grams of carvacrol. As a developer for prints *p*-aminocarvacrol was found to be as good as metol, *p*-aminophenol, or *p*-aminocresol, and the lasting quality of the mixed developer was superior to that of *p*-aminophenol, but not quite so good as that of the others. This work has been done particularly with the view of utilising the abundant source of carvacrol that may be prepared from cymene. Thymoquinol and *p*-aminothymol were also prepared, but they proved to be less satisfactory both with regard to yield and their behaviour as developing agents.

IN *Engineering* for September 12 Dr. W. C. Unwin gives an account of an investigation he has made on the results of notched-bar tests. Dr. Unwin has applied Prof. Martens's method of calculating the "mean error," which differs little from the probable error and is easier to calculate, and has taken the test results given in the paper on shock tests by MM. Charpy and Thenard (Iron and Steel Institute, 1917), and also those in the British Association report for 1918. Dr. Unwin finds that an empirical formula

of the form: Work of rupture/area of fracture raised to a power n, gives closer agreement with the experimental results than other formulæ which have been employed. n ranges from 1·17 to 1·41 for the Charpy and Thenard results. Dr. Unwin considers, however, that the results are too few for a safe generalisation, and that further progress cannot be made until a greater number of careful tests have been made with bars of different sizes, the results of which are as consistent with each other as those of Charpy and Thenard, the value of whose 1917 paper it would be difficult to overrate.

An interesting description, with working drawings, of a Michell thrust bearing appears in the *Engineer* for August 29. This bearing has been made by Messrs. Cammell Laird for H.M. destroyer *Mackay*, and was fitted to the port turbine, whilst the starboard turbine had a thrust bearing of the ordinary type. The pressures on these bearings were 549 lb. and 120 lb. per sq. in. respectively, and it is interesting to note that the oil discharged from the Michell bearing was about 18° cooler than that from the ordinary type. Another valuable point about the Cammell Laird design is in the form of a thrust-indicating device fitted to the bearing This consists of a number of small hydraulic cylinders having rams which bear against the abutment ring which carries the thrust pads. By pumping oil into these cylinders the rams force the abutment ring off its seat, and the whole of the propeller thrust is then carried by the rams. Thus the pressure in the cylinders is a measure of the thrust. On the trials of the *Mackay* the thrusts registered were 59 tons and 56 tons respectively for the port and starboard engines, and varied to 61 tons and 47 tons when turning. Variations in speed were also recorded by the thrust indicator, and give fair curves on a graph. This device is likely to be extremely valuable in solving problems of propeller efficiency and resistance of ships by enabling experiments to be carried out on the ship itself as well as on tank models.

Messrs. George Bell and Sons, Ltd., announce for early publication a new "Card Test for Colour-Blindness," consisting of twenty-four cards devised by Dr. F. W. Edridge-Green. Mr. J. Reid Moir is publishing through *Mr. W. E. Harrison, the Ancient House Press, Ipswich*, a volume entitled "Pre-Palæolithic Man," in which will be given an account of the flint implements discovered in certain Pliocene deposits in East Anglia. The book will also contain chapters dealing respectively with flint fracture, the ancestry of the Mousterian palæolithic artefacts, and the Piltdown remains. *Messrs. Hodder and Stoughton* announce for appearance in their New Teaching Series of Practical Text-Books "Chemistry from the Industrial Standpoint," P. C. L. Thorne; "The Natural Wealth of Britain: Its Origin and Exploitation," S. J. Duly; "Foundations of Engineering," W. H. Spikes; "Chemistry and Bacteriology of Agriculture," E. J. Holmyard; "Applied Botany," G. S. M. Ellis; "Everyday Mathematics," F. Sandon; "The Mathematics of Engineering," S. B. Gates; "Mathematics of Business and Commerce," O. H. Cocks and E. P. Glover; and "Geography of Commerce and Industry," R. S. Bridge. The list of announcements of the *Oxford University Press (Mr. Humphrey Milford)* has just been issued, and contains, among others, the following works:—"Medical Science: Abstracts and Reviews"; "Pathology of War Gases," Dr. M. C. Winternitz; "United States Forest Policy," J. Ise; "Fungal Diseases of the Common Larch," W. E. Hiley; "Effects of the Great War upon Agriculture in the United States and Great Britain," Prof. B. H. Hibbard; "Aristotelis Meteorologicorum Libri Quattuor," Recensuit Indicem Verborum Addidit, F. H. Fobes; "James Tod's Annals and Antiquities of Rajasthan," edited, with an introduction and notes, by Dr. W. Crooke; and "The Heart and the Aorta," Drs. Vaquez and Bordet, translated by Dr. Honeij. A new series of books is to be brought out by the *University of London Press, Ltd.*, entitled "The Education of the Future." It will be edited by Mr. Benchara Branford, who is writing an introductory volume on "The Modern Philosophical Basis of Education." Other volumes of the series will be "Psychology of the Class," F. Watts, and "The Teaching of Geography," Miss A. Booker.

Readers of Nature interested in geology should see the latest catalogue (No. 88, new series) of Messrs. John Wheldon and Co., 38 Great Queen Street, W.C.2, which contains the titles of upwards of two thousand publications relating to geology and mineralogy, conveniently classified under the main headings of Geographical, General Geology, and Economic (Mineralogy, Metallurgy, and Mining). The catalogue is particularly strong in French and German works.

OUR ASTRONOMICAL COLUMN.

Comets.—Mr. H. Vanderlinden has computed the following orbit of comet 1919*c* (Metcalf-Borrelly) from observations on August 24 and 30 and September 5. It differs considerably from that already published, but is evidently more accurate:—

$$T = 1919 \text{ Dec. } 7{\cdot}2721 \text{ G.M.T.}$$
$$\left.\begin{aligned} \omega &= 185^\circ\ 49'\ 37'' \\ \Omega &= 120^\circ\ 59'\ 14'' \\ i &= 46^\circ\ 23'\ 30'' \end{aligned}\right\} 1919{\cdot}0$$
$$\log q = 0{\cdot}046698$$

Ephemeris for Greenwich Midnight.

		R.A.	N. Decl.	Log r	Log Δ
		h. m. s.	° ′		
Sept. 28	...	5 12 8	10 50	0·1943	0·3221
Oct. 2	...	15 21 18	8 50	0·1827	0·3173
6	...	15 30 49	6 48	0·1711	0·3127
10	...	15 40 41	4 43	0·1594	0·3083
14	...	15 50 55	2 37	0·1478	0·3041

The magnitude is 8·8 on October 2; brightening slowly.

Many naked-eye observations of comet 1919*b* (Metcalf-Brorsen) are reported, so the brightness evidently exceeds the tabular value. No revised elliptical elements have yet been published. The errors of the Copenhagen ephemeris are now quite appreciable, so a little sweeping may be necessary to find the object.

The Future of the Transit Circle.—Mr. J. E. de Vos Van Steenwijk has a paper on this subject in the September *Observatory*. Some ardent supporters of photography think that our transit circles might be scrapped altogether. The paper reminds us that fundamental places of the sun and principal fixed stars are still needed, but they may safely be left in the hands of a few observatories. Reference stars for photographic plates must also be observed, but the number required may be greatly diminished if portrait lenses with a large field are used for the photographs. The paper suggests two other useful fields: (1) A meridian parallax Durchmusterung; while the individual results might not be very accurate, probably a good many stars would be found that would repay

further research. (2) It is desirable to obtain accurate positions and proper motions of as many stars as possible of types M and N. Owing to their non-actinic colour, these stars are more suitable for visual than for photographic research.

HEREDITY AND EVOLUTION.

IN recent investigations on the subject of heredity much interest has centred around the question of the determination of sex. In this connection attention may be directed to a short but important paper by Prof. Jacques Loeb (Proc. Nat. Acad. Sci., Washington, vol. iv., 1918, pp. 60–2), in which he describes observations on the sex of frogs developed from parthenogenetic eggs incited to segmentation by the mechanical stimulus of puncture. Twenty of these creatures reached ages of from ten to eighteen months, several attaining the size of the full-grown, normal adult male, to which sex belonged seven of the nine the gonads of which were examined, the other two being females. Hence it appears that frogs of either sex may arise as the result of "artificial parthenogenesis." Cytological study demonstrated the presence of the full (diploid) number of chromosomes in these males, and Prof. Loeb infers that the female is probably heterozygous for the sex-character. But there seems to be good evidence for an "indifferent" condition as to sex in some immature frogs at least, as shown by the well-known researches of Prof. R. Hertwig and suggested by observations of Prof. Loeb in a former paper of his that the testes of a male just after transformation may contain a few eggs. It is doubtful, therefore, whether sex in frogs is absolutely determined by the nature of the germ-chromosomes.

Individual animals in which the secondary characters of the two sexes are combined afford a curious puzzle to students of this question. In the *Journal of Genetics* (vol. vii., No. 3) the Rev. J. E. Hull gives details of a few cases of such "gynandry" among spiders. In one case (*Œdothorax fuscus*) the specimen externally was "completely male on the left side and female on the right"; in another (*Maso sundevallii*) it was "male on the left side, but not quite female on the right," the apex of the right palp being somewhat swollen. A third spider (*Lophomma herbigradum*) was perfectly male on the right of the cephalothorax, with modified falx and palp, and female on the left, but the abdomen showed the characteristic female epigyne half-developed on the right, the left half of the abdomen being male. Such abnormalities, though highly interesting, are so rare that it will probably be long before they will yield much enlightenment on fundamental problems of sex. In the same issue of the *Journal of Genetics* Mr. D. W. Cutler describes the spermatogenesis of infertile hybrids between pheasant and Gold Campine fowl, and finds that the process is abnormal: "The failure of the synaptic threads to form bivalent chromosomes is evidently the cause of sterility in the hybrids." This result is compared with those derived from the study of the germ-cells of other sterile hybrids, in some of which the sex is apparently determined by the sex of one of the parent species.

A short but noteworthy contribution to this subject is Drs. L. J. Cole and W. A. Lippincott's paper on the relation of plumage to ovarian condition in a Barred Plymouth Rock pullet (*Biol. Bull.*, vol. xxxvi., No. 3). This bird assumed partially the male plumage, and the change was found to be due to a large ovarian tumour; though the abnormal feathers were like those of a male in shape and structure, they resembled hen feathers as regards "barring." This, the authors believe, differentiates "secondary sexual dimorphism from dimorphism caused through sex-linkage as illustrated by the barring." After an implantation of normal ovarian tissue, new feathers which were definitely female grew in a few weeks.

New subjects for hybridising experiments are afforded by the northern and southern forms of African ostrich, the results of crossing which are described by Prof. J. E. Duerden (*Journal of Genetics*, vol. viii., No. 3). These two species (or subspecies) interbreed freely, and the offspring are fertile among themselves and with the parent forms. "Everything points to the distinctive characteristics of the two species as having separate factorial representation in the germ plasm." The bald patch on the head of the northern race is dominant to the feathered condition of the southern, but in most features "blended" inheritance is apparent. None of the specific characters appear to have any adaptive value.

The application of Mendelian analysis to economic plant-breeding is well exemplified by A. St. Clair Caporn's studies (*Journal of Genetics*, vol. vii., No. 4) on early and late ripening in an oat-cross and on variation in glume-lengths of extracted parental types and the inheritance of purple colour in a wheat-cross (*Triticum polonicum*×*eloboni*). "Earliness" and "lateness" in oats are not sharply defined characters; they are spread over a period, though "the ripening times of the parents used did not overlap." The hybrids were more or less intermediate, while in the F_2 generation there was "evidence of early, late, and many intermediate forms." Some remarkable results were obtained from the wheat-crossing experiments. In the F_2 generation a marked change in the average length of the glumes in homozygous long-glumed plants "as compared with the average of the parent *T. polonicum*, under equal conditions, persists right through into the F_3 generation." The inheritance of purple pericarp colour "is distinguished by one cardinal and unaccounted for anomaly; segregations analogous to the F_2 segregation have not been found in the F_3 generation."

Most students of "Mendelism" would probably hold the opinion that little remains to be added to our knowledge of the classical case of the blue Andalusian fowl But Dr. W. A. Lippincott (*Amer. Nat.*, vol. lii., No. 614) gives reasons for believing that 'the 1 : 2 : 1 ratio is in reality a combination of two 3 : 1 ratios," and that the condition in the blues is due to the combined action of two factors, one of which restricts the distribution of the black pigment within the feathers in such a way that it gives the characteristic blue-grey appearance, while the other extends the black pigment to every feather of the bird. Somewhat similar suggestions had previously been made by R. Goldschmidt and by A. L. and A. C. Hagedoorn. According to Dr. Lippincott, the birds usually defined as "white splashed with black" would be more correctly described as "blue-splashed." His theory seems largely dependent on the possibility of "crossing-over" of determinants in the chromosomes, for which no evidence is yet forthcoming, and he admits that "if these cross-overs should not be found, it might at first appear that the interpretation of the case of the blue Andalusian is in all probability exactly what has been suggested from the first, namely, that blue is a heterozygote intermediate between the parental types."

A noteworthy critical discussion on the factors of organic evolution has been contributed by Prof. L. B. Walton to the *American Naturalist* (vol. lii. Nos. 622–23). He believes that heritable characters in general arise from preformed unit factors that may have been in existence during long geological periods; the

modern study of genetics gives no means of distinguishing a new factor from one long in existence. He suggests that the mutations studied by De Vries in plants, and the modifications obtained by Castle in mammals, are due to the combination of pre-existing factors, while the famous mutations in flies elucidated by Morgan "are in the nature of modal fluctuations having no definite cumulative value." Prof. Walton's own definite contribution in this paper is found in his summary of the direction of axial rotation in Euglena and other Protozoa which "is best explainable on the basis of the apparent east-west motion of the sun having influenced the movement of the organs of locomotion." This seems an insecure foundation for such a generalisation as the author's statement that "the primary factors in evolution are environmental, and thus dynamic."

G. H. CARPENTER.

CHEMISTRY OF "BURGUNDY MIXTURE."

THE chemistry of "Burgundy mixture" is practically important, because to give it the greatest efficiency it should possess a maximum fungicidal power and a minimum potentiality for injuring foliage. The reaction of sodium carbonate and copper sulphate solutions has been studied by Pickering and by Ravaz, but, according to a paper contributed to the August Journal of the Chemical Society by Messrs. Robert L. Mond and C. Heberlein, the problem is more complex than they considered. The latter authors have studied the reactions of copper sulphate with varying proportions of sodium carbonate and of sodium hydrogen carbonate; have determined the amount of absorbed sodium carbonate and the ratio of copper oxide to carbon dioxide in the various precipitates and the amount of basic copper sulphate in the mixtures; and have studied the solvent action of carbon dioxide and the change of the colloidal precipitate to a crystalline form. As a result of their experiments Messrs. Mond and Heberlein conclude that three distinct copper compounds are formed when sodium carbonate and copper sulphate solutions are mixed:—(1) Insoluble hydrated basic copper carbonate (the bulk of the precipitate); (2) insoluble hydrated basic copper sulphate; and (3) soluble basic copper sulphate in the form of a hydrosol; the proportions of which vary with the conditions of precipitation. One molecule of copper sulphate is completely transformed by 0·93 molecule of sodium carbonate instead of the one molecule theoretically necessary. In a 1 per cent. mixture of copper sulphate and sodium carbonate (in the proportion 1 : 0·93 mol.) made at 15°, 9·6 per cent. of the copper is present as soluble basic sulphate, the basic carbonate contains copper oxide and carbon dioxide in the ratio 2·2 : 1, the insoluble basic sulphate contains copper oxide and sulphur trioxide in the ratio 15 : 1, the precipitate contains absorbed sodium carbonate in the proportion of 1 part to 74 of copper oxide, and 52·4 per cent. of the carbon dioxide is evolved. At higher temperatures more carbon dioxide is evolved, all being expelled on boiling. The amount of basic sulphate formed decreases as the proportion of sodium carbonate increases, the proportion in solution (but not that of the basic carbonate) increasing with the amount of free carbon dioxide. At first the precipitate is wholly colloidal, but eventually it becomes crystalline, the colloidal condition apparently being conditional on the absorbed sodium carbonate. The transformation is accelerated by free copper sulphate, carbon dioxide, or sodium hydrogen carbonate, but retarded by sodium carbonate or 0·02 per cent. of glue.

ÆTHER AND MATTER: BEING REMARKS ON INERTIA, AND ON RADIATION, AND ON THE POSSIBLE STRUCTURE OF ATOMS.[1]

PART II.—THE POSSIBLE STRUCTURE OF ATOMS AND THEIR RADIATION.

HOW, then, are we to explain the different kinds of matter? Here we enter upon territory so recently annexed as to be still very debatable; but progress has been and is still being made, and it is only through the work of recent explorers that we can attempt to answer the question at all. It is invidious to select names, but I must mention Rutherford, Soddy, Barkla, Bragg, Moseley, Nicholson, and Bohr, among many others. Moseley—as brilliant as any of them, and patriotically self-sacrificing like all our splendid youth—was killed, alas! by a Turkish bullet at Gallipoli; though not before he had made an immortal discovery. How much more might he not have accomplished had it not seemed good to evil Powers to impose by force their dominance on the world!

To give a certain and definite answer to questions about the structure of the atom is premature. I can only state the answer which at present tentatively appeals to me and, I think, to others. Your professor of natural philosophy (Sir J. J. Thomson) is lecturing, I see, on Saturday afternoons concerning spectroscopic evidence on this great subject, and he will, no doubt, carry the matter further.

Meanwhile, and very briefly, the idea about the atom which at present seems most likely to be on the path towards truth is a central positive nucleus surrounded by a system of negative electrons—so much is pretty certain—while according to one theory the system is composed of revolving electrons moving under an inverse-square law in regular orbits, very like the sun and planets. The orbital movement is governed by electric force instead of by gravitation, but the laws of motion, and the perturbations which may be caused by outside forces, are very like those familiar to astronomers.

According to Moseley's experimental counting and Bohr's theory, hydrogen seems to be like a sun with one planet, just a positive and a negative electron, the two being equal electrically, but differing in inertia, the positive being the more massive, though probably for that reason the smaller or more concentrated of the two. Helium seems to have two central unbalanced positive charges and two revolving negative; lithium, three of each; beryllium, four; boron, five; carbon, six; nitrogen, seven; oxygen, eight, and so on, according to the number of the element in Mendeléeff's series—a number something like half the number expressing its atomic weight.

The number of positive atoms in the nucleus was counted for several elements by Rutherford, and the number of negative corpuscles in the orbit was counted by Moseley; the two numbers agree. Normal atoms are therefore electrically neutral, so that their external electric attraction at any reasonable distance is nil; but it is supposed that at atomic or molecular distances the outer or orbital electrons which can interlock with those of others determine the atom's chemical affinity and all the chemical behaviour of the substance. An atom with one or two outlying planets—let us surmise—would be an active chemical element, a monad or dyad perhaps. An atom with a close-grouped, self-contained system would be an inert element of the argon-neon-helium series. These

[1] Amplified from a discourse delivered at the Royal Institution on Friday, February 28, 1919, by Sir Oliver J. Lodge, F.R.S. Continued from p. 19 (September 4).

might exhibit chemical properties, perhaps, under enormous pressure. The heavier atoms contain the most particles, and must have the most complicated structure. There is every grade, from the simplest, hydrogen, with one electron, to the most complex, uranium, with ninety-two. There is room for ninety-two elements in the series, and no more. All these are actually known except five or six. There are only these few unfilled gaps in the chemical series of elements as thus planned.

Radio-activity.

A complicated atom has a certain amount of instability, and may fall down occasionally into the next simple grouping, flinging away one or more of its units. When this happens there is a sort of atomic cataclysm or explosion; a projectile and some quanta of energy are emitted. This is the phenomenon of radio-activity. Uranium after three (or possibly four) such eruptions becomes the element three (or four) steps down the series, viz. radium. Radium after five more explosions becomes apparently the well-known and stable element lead, or at least something chemically indistinguishable from it, though perhaps of slightly different atomic weight,—what has recently been called an "isotope" of lead. That is the kind of statement that without too much rashness can be cautiously and tentatively made.

At every serious cataclysm an α-particle or atom of helium is emitted from the nucleus, accompanied by a β-particle or negative corpuscle from somewhere, usually from the planetary system. A sympathetic æthereal gush of γ-rays accompanies the eruption. A definite unit of energy—a quantum or a simple multiple of it—is emitted at each explosion; and the remaining electrons then settle down into their new orbits, the element changing in character and chemical properties accordingly.

A catastrophe of this kind can be produced by a sufficiently rapid projectile, an α- or β-particle shot off, say, by radium; and a minor catastrophe or emission of a β-particle can also be produced by the accumulated energy of properly attuned X-rays. When an X-ray or ray of ultra-violet light agrees in frequency with the orbital frequency of an electron, we can suppose (not without a little difficulty) that its energy is absorbed until a quantum has been accumulated, and then a β-ray or excessively rapid electron is emitted.

Remarks on the Quantum.

In my view, it should not be thought that energy exists in numerical bundles or quanta; the discontinuity is not really in energy, but in the atom. Atomic properties are essentially numerical and discontinuous, and we ought not to be surprised at an equilibrium which needs a specific amount of energy to upset it. The energy must be supplied by the disturbing impulse; but in the case of ultra-violet or X-ray radiation the energy can only be attributed to the disturbing impulse on the principle of resonant or syntonic accumulation; for its intensity does not matter. Nor ought it to matter so long as the tuned impulse is repeated often enough—a repetition for which an extremely minute fraction of a second is ample. What matters is not the brightness or energy of the incident radiation therefore, but its frequency. On the other hand, a β-projectile cannot effect a real disturbance unless it possesses a minimum quantum of energy; for in that case there is no accumulation.

The quantum, considered merely as a finite store of energy, is susceptible of exceedingly elementary illustration. Here is a case of stable equilibrium (a simple pendulum or a round-bottomed flask loaded so as to oscillate stably) which responds to the slightest touch and returns to equilibrium. There is no quantum about that. But here is another case of stable equilibrium (a brick or block or pillar standing on end) which takes no notice of any but a finite force, and requires a finite amount of energy to upset it, viz. its weight multiplied by the elevation of its centre of gravity as it revolves round its lower edge; this being also the amount of energy emitted when it falls. Or there may be a union of the two kinds of equilibrium. This rounded rocking flask, for instance, or a rocking-horse, may accumulate oscillations until the energy reaches a sort of quantum, when it upsets and breaks or causes an accident. This last is the kind of stable equilibrium which we meet with in an atom.

A flying particle below a certain limit of energy can alter the eccentricity of an orbit, and may thus excite some simple radiations which continue until the orbit becomes circular again; but a synchronous X-ray disturbance, however intrinsically feeble, may precipitate a catastrophe; and simple facts of this kind seem to be, in the main, responsible for the general notion of quanta of energy. The really remarkable thing about a quantum, the thing which makes it so essentially worthy of attention, is the fact that it is a universal constant; the same amount of energy is found associated with every kind of matter—the same, or differing only by simple multiplication. Hence the notion at one time put forward that energy itself might be atomic and exist in indivisible packets, like cartridges.

Hypothetical Structure of Atoms.

The real facts concerning the quantum, which are the result of observation, suggest, when interpreted properly, that there are stable electronic orbits in an atom, and that these follow a regular law of succession, analogous perhaps to Bode's law of planetary distances in the solar system. Spectroscopic evidence —the so-called Balmer's series of lines—strongly bears out this idea. For there is what is called K radiation, of highest frequency, apparently due to perturbations of the innermost, the most rapid, ring; L radiation of lower frequency from the next outer ring; M radiation from a ring outside this; and recently there is talk of a J radiation of extra high frequency from a ring still closer to the nucleus—perhaps quite close to it, part of it perhaps—and, anyway, well within the K ring.

The frequencies adapted to bring about an atomic catastrophe, or which are emitted during perturbations, are usually high up in the series of X-ray series of vibrations, far above visible light. I assume that these frequencies correspond with the frequency of orbital revolution, and that the inverse-square law holds good. The more massive the nucleus, the greater must be the frequency of orbital revolution at a given distance, in accordance with Kepler's third law. The square of the frequency multiplied by the cube of the radius of the orbit will be constant for all the orbits of all the atoms of any given substance, and will give the attracting force of the nuclear centre for that substance.

In other words, this product (or, what comes to the same thing, the radius multiplied by the square of the speed) will correspond with the number of unneutralised positive charges which go to make up the nucleus. It will give, in fact, the number of the element in the Mendeléeff series. The K radiation frequency from uranium, therefore, must be exceptionally rapid, because the nucleus is so strong. For hydrogen, the nucleus of which is only 1/92nd of that of uranium, the orbital frequency might be comparatively slow, not higher than the ultra-violet; while the L radiation from hydrogen, it is now thought,

may be within the limits of the visible spectrum, an M series being, perhaps, in the infra-red.

But how comes it that hydrogen, with only one electron, can have a K series and an L series and an M series at all? Bohr's theory suggests that even a single electron may have alternative orbits—not necessarily occupied; and the spectroscope strongly suggests that the radii of these alternative orbits run as the squares of the natural numbers

1 4 9 16 25, etc.

The frequencies, or reciprocals of periodic times, would then be as the inverse cube of the natural numbers

1 $\frac{1}{8}$ $\frac{1}{27}$ $\frac{1}{64}$, etc.

and this is, approximately and roughly, what the K, L, M series of spectrum lines correspond with—with some exceptions.

When a cataclysm occurs and an electron is expelled, it is expelled, as I think, with the velocity which it possessed in the atom just before it burst its bonds and flew off. For the energy required to fling a planet to infinity, under an inverse-square law, is just double the energy with which it was already moving in its circular orbit. Its own orbital energy is, therefore, the quantum of energy that has to be supplied in order to get a satisfactory ejection. Some of it might be supplied by the falling in of other particles from their original orbits; for their kinetic energy therein would be inversely as the distance from the nucleus. Hence if K, L, M orbits have the radii 1, 4, 9, three units of L energy would represent the fall from L to K, and this added to the original L energy would give the quadruple L energy which is equal to the K energy, and able to eject a K particle. Similarly, a ninefold multiple of the M energy, eight units of which would be acquired by falling to K, would supply that particle with the ejection energy equally well.

Would an M particle falling to L be able to eject an L particle? $\frac{1}{4}-\frac{1}{9}=\frac{5}{36}$ of a K unit of energy would be acquired in the fall from M to L—that is, $\frac{5}{4}$ M units,—so altogether $\frac{9}{4}$ of M energy would be transmitted, and that, being equal to a unit of L energy, ought to be sufficient.

Hence, in general, particles may be ejected from any ring, either by direct impact from outside, or by accumulated disturbance of X-rays, or by a collapse of particles from one orbit to the next; and from an immense group of atoms, as in a visible speck of substance, all kinds of radiation can be emitted simultaneously.

Are we to suppose that there is only one electron in each orbit, or may several of them distribute themselves over a ring in accordance with some law of stability? Both alternatives are possible, and both are likely to be found in Nature. It seems scarcely likely that a uranium atom should possess ninety-two different orbits, although it does contain ninety-two electrons. Yet even this number of orbits is possible within the dimensions of an atom. We need not exclude the possibility as taking up too much room. For, given the size of the ultra-innermost or J orbit as 1, the outer orbit would, on Bohr's law pressed to extremes, be $(92)^2$ times that radius—say, 8464 times the size of the innermost orbit; but if this innermost orbit is near the uranium nucleus, which may be $\sqrt[3]{92}$, or, say, 5 times the radius of the hydrogen nucleus, the boundary or confine of the atom is some 10,000 times as far away; leaving, therefore, just room enough for the ninety-two Bohr orbits, though not much more than is required.

Hence, if there were any reason to desire them separate, they could be made room for, without endowing the atom with outlying or ever-ready electrons likely to confer upon it very active chemical properties. But, so far as I see, so many separate orbits are not likely; for there is every probability that periodically, as you ascend the series, the outer ring is not occupied by a single electron, but by a closed, compact sort of structure of many electrons, with very little outside affinity; so that we reach periodically an atom which is chemically inactive—helium, neon, argon, krypton, etc.—up to emanation, or what Ramsay called niton. So little cohesion holds between such atoms that they are able to exist as permanent gases, in spite of the high density of some of them. This, at least, appears to be the view of Rutherford and Soddy. Helium only condenses to a liquid when cooled down to near the absolute zero of temperature. Its cohesion or intermolecular attraction is nearly nil.

A Fanciful Analogy.

If I attempt to compare the supposed alternative orbits in an atom with the known orbits of the solar system, it is mainly to emphasise, provisionally and tentatively, and perhaps semi-humorously, the astronomical view of the atom, and to bring out still more strongly the resemblances whatever thorough differences there may be as well.

I write down the squares of the natural numbers, therefore, and underneath put the initial letters of the names of planets, with its real distance written under each in the same units.

Radii of Bohr's atomic orbits	1	4	9	16	25	36	49	64	81	100	121	144	169	196
	m	V	E	M	Asteroids		J			S				U
Planetary distances	3·9	7·2	10	15·2	20–35		52			54				192

The obvious suggestion is that asteroids should be looked for between Jupiter and Saturn, and between Saturn and Uranus; but I would not venture to predict the existence of any such bodies on the strength of this analogy, because you will doubtless have noticed that no analogue of the planet Venus appears in the list of atomic orbits; the scheme provides no place for her—a lamentable omission which must discredit and, I expect, condemn even the analogy. Nevertheless, I make no apology for introducing it in order to emphasise astronomical similarities in the possible structure of an atom.

Quantitative Interpolation.

On Atomic Radiation.

Permitting ourselves this view of the atom as a working hypothesis, we have to picture each atom as an attracting centre or nucleus, with a number of alternative orbits in regular succession round it, but not all necessarily occupied by revolving electrons. The atoms of different elements differ in the number of positive units in the nucleus, and in the corresponding number of revolving negative units; in fact, the diverse chemical elements in their atomic constitution form a definite arithmetical series with common difference 1. There is a discontinuity or finite step in passing from one element to the next in the series; there is no continuous passage from one to another; hence if the physical transition or mutation ever occurs, it must be by some sort of sudden convulsion.

To extract laws for this hypothetical structure, suggested by the labours of many workers, we may attend to the different rings of one kind of atom, or we may attend to the corresponding rings in different kinds of atom. Each, for instance, has an innermost ring, which it is convenient at present to call the K ring

because of the shortest wave-lengths, or so-called K spectrum, which its perturbations emit. And in ascending the series of elements, as the nucleus gets stronger by addition of units, the electron in this innermost or K ring must revolve faster and faster to counterbalance the greater attracting force. Its orbit will accordingly get smaller and smaller, in the proportion proper to the law of inverse square. And the frequency will increase for both reasons, *i.e.* for both the greater speed and the shorter journey. The spectrum accordingly, while preserving the same type, ascends the ladder of frequency.

Suppose the atomic number, or strength of the nucleus in atoms of successive elements, increases in arithmetical progression N−1, N, N+1, etc., then the radius of the given type of orbit may shrink in the same proportion, so that rN is constant; and the velocity v may increase in the same proportion, so that rv is constant; or, in other words, so that the moment of momentum in corresponding rings of different atoms is the same. There is good evidence that such is the case. The law, so far as it is a law, is styled by Prof. Millikan the atomicity of angular momentum. If the value of mvr or $mr^2\omega$ differs in different rings, it differs by finite steps.

The frequency of orbital revolution will depend on v directly and on r inversely, so the frequency $(v/2\pi r)$ will increase in the proportion of N^2; and this, in some form of other, is known as Moseley's law.

The energy, $\frac{1}{2}mv^2$ in a given type of ring, will also depend upon N^2 in different atoms, and is therefore simply proportional to the frequency. The orbital energy is half the energy with which a particle breaks loose (or is driven to infinity) whenever a convulsion occurs. The convulsion can be stimulated by X-rays or ultra-violet light of the right frequency; their energy appears to be stored by resonance until the critical breaking-up point is reached. The ratio of emission energy to frequency is a remarkable universal constant, and is called h, the quantum. It is not energy, but the accumulation or integral of energy for a certain time; and it is permissible to write $mv^2=2mu^2=hn$; because the emission velocity u (the velocity from infinity) is $\sqrt{2}$ times the orbital velocity v. But h, or rather $h/2\pi$, may also be taken as representing the orbital angular momentum mvr (more strictly, if the orbit is at all elliptical, mvp) for the ring whence the particle came. It would be rather convenient if the designation h were transferred to $h/2\pi$ before it is too late; but I must leave this minor change to the approval of leaders in this subject.

I may point out that this constancy of angular momentum in different orbits bears a curious analogy to Kepler's second law about rate of description of areas in the same orbit. And, if a coincidence, it is odd that the symbol h should have been used both for Kepler's $r^2d\theta/dt$ and for an atomic quantity which is also $r^2d\theta/dt$ multiplied by $2\pi m$.

Within each atom Kepler's laws must presumably hold; so r^3/t^2, or rv^2, is constant for the different circular orbits in each atom; whence the energy in successive rings of one atom is inversely as their radii; hence the ring most likely to eject a particle is the innermost or K ring.

This characteristic constant rv^2 of an element is proportional to the central attracting force, and therefore proportional to N. Hence it goes up step by step in the series of atoms, as N does.

Summary.

N is Moseley's atomic number, and equals the number of orbital electrons, or the number of unbalanced positive charges in the nucleus. The constant rv^2 is characteristic of all the rings in one atom (N being constant). The product rv is a constant characteristic of a given type of ring in the whole series of atoms (N going up step by step); but in any one atom this product rv ascends from ring to ring in regular arithmetical stages, the same stages as $\sqrt{r}$.

The product rv^2 is constant inside each atom, and proceeds by steps from atom to atom; while the product rv is the same for different atoms, but changes inside each atom and proceeds by steps from ring to ring. In fact, we may write:—

For all the Rings in One Atom.

Central force	rv^2 is constant.	
Angular momentum for the rings in one atom ...	rv	$\propto \sqrt{r}$
Energy for the same ...	v^2	$\propto 1/r$

For any Ring in any Atom.

Central force for any ring in any atom	rv^2	$\propto$ N

For the same Type of Ring in Different Atoms.

Radius of given type of ring in any atom ...	r	$\propto 1/N$
Orbital velocity in ring of that type	v	$\propto$ N
Moment of momentum in given type of ring ...	rv	is const. as regards N.
Frequency in that type of ring	v/r	$\propto N^2$
Energy in same	v^2	$\propto N^2$

So for a given type of ring in different atoms the orbital energy is proportional to the frequency; which is a curious result thoroughly consistent with Moseley's law, ascertained by experiments on emission, and true, at any rate, for emission energy. The ratio

$$\frac{\text{emission energy}}{\text{frequency}}=\frac{mv^2}{v/2\pi r}=2\pi mvr=2\pi.mr^2.2\pi r=2\pi I\omega$$

So if we call this h, or a multiple of h, then on our hypothesis $h/2\pi$ is the indivisible unit of angular momentum for an orbital electron.

The speed with which an electron is ejected is very high, something like 0·9 of light, so the increase of mass at high speeds must be taken into account in propounding a reason for the emission of corpuscles.

Radiation Heterodoxy.

In considering the radiation from an atom, I have virtually made the hypothesis that so long as orbits are circular they do not radiate, but that if perturbed into ellipses, with corresponding fluctuation of speed —as they would be by the influence of a flying charge passing through or near them—then they would radiate, with the proper orbital frequency, until the eccentricity disappears again and they resume their stable circular orbit once more, though, of course, they might be so much perturbed as to eject a particle. Any one of the rings, if perturbed at all, may radiate and give appropriate spectral lines. An external synchronous alternating field will also cause them to absorb energy, even though they were not radiating any until the extra energy arrived.

This hypothesis, if at all regarded, is equivalent to a request to mathematicians to reconsider their theory of electronic radiation. Radiation intensity is known to be proportional to the square of acceleration (Sir Joseph Larmor, and to some extent FitzGerald and Hertz, established this), and I must admit that the reasoning seems to make this law applicable to every kind of acceleration; but my rash suggestion is that

it may be only speed-acceleration that is really effective, and not transverse or curvature-acceleration at constant speed. For this will not perturb the lines of force holding the electron to the nucleus, but will leave them in a constant condition so long as the orbit is circular and the speed therefore constant. There is a recognised difference of the same sort in connection with varying inertia; its value is not affected by transverse acceleration, with the speed left constant, but it is affected by longitudinal acceleration, which alters the speed.

So I am in hopes that it may be found that this latter or speed-acceleration is what is responsible for radiation, and that mere curvature at constant speed in a circular orbit need not radiate at all, provided always that the superposition of an external alternating field of the right frequency may cause absorption. Many of the difficulties connected with the stability of the astronomical atom would be evaded if the theory of radiation could be modified in this way, and the excitation of characteristic radiation by almost any kind of perturbation of the orbit would be intelligible.

Speculations on Radiation and Atomic Structure.

Bohr's remarkable theory of atomic structure does not pretend to be strictly dynamical; it is partly empirical, being based on the discontinuity signalised by Planck's constant, but it is very brilliant, and extensively justifies itself by agreement with facts.

His expression for the frequency of radiation emitted by any element is virtually, to a fair approximation,

$$n=\frac{2\pi^2me^4}{K^2h^3}\cdot\left(\frac{E}{e}\right)^2\left(\frac{1}{p^2}-\frac{1}{q^2}\right)$$

where $\frac{E}{e}$ is Moseley's atomic number N, the number of unbalanced charges in the nucleus or the number of electrons in the atom, and where p and q are integers, of which p changes from series to series, while the lines in each series are given by the mutations of q. For heavy atoms the E in the above formula should be E *minus* a geometrical function of all the other electrons inside the radiating orbit, because they will affect the central attracting force. In this way outstanding discrepancies may plausibly be explained. But the remarkable thing is that the formula gives the frequencies, not merely relatively, but absolutely. For if the experimental values otherwise obtained for e, m, and h are inserted, the constant outside the brackets, called Rydberg's constant, which is spectroscopically determined and known to be the same for all elements, comes out right. A very notable fact!

The above expression for spectral lines not only agrees with the Rydberg-Balmer known spectroscopic series, and with the kind of formula given by many pioneer workers, but has been able to predict other series which have been afterwards observed. It also accounts for many extra-low-frequency lines which, though not obtainable in the laboratory, are observable astronomically by suggesting that they come from very large masses of highly rarefied gas. For under such conditions the atoms would have more room and could possess far outlying or ultra-Neptunian electrons, and yet have total substance enough to display their spectra.

To contemplate the emission of radiation, both waves and particles, we may picture one of the satellite electrons in a many-orbited atom struck or so thoroughly perturbed by the sudden arrival of a foreign charge as to precipitate it into the next inner ring, ejecting the constituent of that ring into the one below, and so on, after the manner of the "jack for mustard" game with a series of wooden bricks set up on end.

Wave-emission should accompany each transition. The effect of precipitating the innermost electron on the body of the nucleus is not clear; but a compound nucleus must be a strangely interlocked conglomerate, and an explosion seems not unlikely, especially if one of the supposed binding negative electrons were ejected. The potential gradient close to a nucleus is prodigious.

The effect of the arrival or departure of a charged particle at the nucleus would be suddenly to change its intrinsic attracting force; and this of itself would render all the orbits elliptical for a time, with eccentricity $\frac{1}{N\pm1}$,[2] thus exciting radiation of several frequencies. If the radiation ceased when the eccentricity was got rid of, a new circular orbit would be taken up; and thus perhaps discontinuities might be accounted for in a dynamical manner.

The effect of properly attuned X-rays or ultra-violet light, if it is to be accomplished through resonance—and it is difficult to account for its independence of intensity otherwise—seems to require a fair range of frequency in those rays; for their effect on a revolving electron would naturally be to increase its angular speed and so throw it out of tune with the particular disturbance to which it initially responded. The sectorial area swept out would increase, the radius vector would increase, the linear speed would therefore diminish in spite of the resonant effort to increase it—unless, indeed, under the peculiar conditions in an atom, there may be some compromise. The alternative would be for the electron to be constrained, under conditions of stability, to maintain its frequency unaltered, either proceeding in an outward spiral towards a position of Planckian instability, or trying still to obey the law of inverse squares by increasing the eccentricity of its orbit with given axis major until it becomes practically parabolic.

This could represent an inversion of the process by which the electron may have been originally bound, according to Bohr's theory of what happened before the atom became neutral. For it is to be presumed that a positively charged α-particle, after ejectment, neutralises itself by accretion and settles down.

Conclusion.

I have led you over a great deal of territory in a hurried manner, and occasionally have entered on regions where the ground is not yet solid and secure. Let it be granted that the chemist may naturally object to an astronomical atom and may prefer a more static or geometrical structure, although such a structure would have less clear and explicable properties. The static or Boscovich atom, with purely hypothetical interior fluctuations of force, leaves every-

[2] This can be proved as follows:—
For a circular orbit

$$\frac{\gamma v^2}{r}=\frac{\mu}{r^2}$$

and

$$\gamma^2v^2r^2=k^2=\mu r.$$

When μ suddenly changes to $k\mu\left(\text{where } k \text{ may be } \frac{N\pm1}{N}\right)$ the velocity does not instantly change, but the orbit acquires an a and an e, such that

$$a(1-e^2)=\frac{k^2}{k\mu} \text{ or } e^2=1-\frac{r}{ka};$$

also

$$\frac{\mu}{r}=v^2=k\mu\left(\frac{2}{r}-\frac{1}{a}\right).$$

This last gives

$$\frac{r}{a}=2-\frac{1}{k},$$

so

$$e^2=1-\frac{1}{k}\left(2-\frac{1}{k}\right)$$

$$=\left(1-\frac{1}{k}\right)^2.$$

And the place where the sudden impulse occurred becomes an apse of the new orbit, because $r=a(1\pm e)$. (See also Appendix I. in *Proc. R.I.*)

thing in the dark, and is therefore less tempting to a physicist, until some physical explanation of those fluctuations can be given. At present they seem to be postulated merely in order to secure positions of equilibrium in which an electron can settle down. Orbital revolution achieves the same end, in apparently a more complicated but really a more tractable manner. Moreover, it confers upon an atom the sort of energy and structural velocities which are conspicuous in the various types of radio-activity. True, it is a working hypothesis at present, and nothing more, but it seems likely to be a fruitful one; and that is its present justification.

The subject is in the nascent or rapidly growing stage; and, provided we refrain from dogmatism, it is legitimate thus tentatively to survey and explore the boundary between knowledge and ignorance, and to speculate as to what may be the next stages in the exhilarating pursuit.

The apparent resemblance between an atom and the solar system opens up extraordinary vistas for further inquiry. Optics and gravitation still have many secrets. The interactions between æther and matter are as yet barely understood. We know that the energy of an electric current is really in the æther, *i.e.* in the magnetic field surrounding the current; but we must admit that the electromagnetic explanation of inertia is no ultimate explanation; it is but relegating the property to some fundamental property of the æther, of which substance presumably matter itself may in some way be composed.

Evidence suggests that the æther is an excessively dense substance, and that it circulates slowly along lines of magnetic force.[1] But though so dense we have no means of apprehending it directly. Matter, though so comparatively filmy and fragmentary, yet looms large in our estimation because of our material sense-organs; its properties force themselves on our attention, because, in fact, our bodies are composed of matter. But underneath and behind all the known properties of matter lie the unknown properties of the æther of space; and if we are to create a true philosophy we must attend continually to æther as well as to matter in the physical universe. The æther makes no appeal to our senses, but it is none the less real for that. Sensation is no test of reality—many of the most important things are in the insensible universe; and he is the wisest man who shuts the door on no opportunity for investigation, but keeps his mind open and is ready to explore every avenue towards truth.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

EDINBURGH.—Considerable developments have recently taken place in the departments of pure and applied mathematics of the University. Since 1914 the department of pure mathematics has occupied a separate building, the Mathematical Institute, in ground adjacent to the Arts Quadrangle. This building contains lecture-rooms large and small, mathematical laboratory, reading-room with students' library, research-room with a library of mathematical periodicals and advanced works, and rooms for the staff. The laboratory course comprises interpolation, construction of mathematical tables, numerical solution of algebraic and transcendental equations, numerical integration, least squares, graduation or adjustment, fitting of normal and skew frequency curves, correlation, practical Fourier analysis, spherical harmonic analysis, periodogram analysis, with drawing-board work in nomography, descriptive geometry, and cartography.

The most recent development is the institution of a diploma in actuarial mathematics. This is intended for students who are employed in the numerous life insurance offices in the city of Edinburgh, and are, therefore, only part-time students of the University, attending, however, day, not night, classes. The course, which covers two years, is conducted on the mathematical side by Prof. E. T. Whittaker, F.R.S., and on the actuarial side by Dr. A. E. Sprague, president of the faculty of actuaries. Students who obtain the diploma will be exempted from Part I. and Part II. of the faculty's examinations for fellowship.

The Mathematical Institute is the meeting-place of the Edinburgh Mathematical Society, and houses the library of the society.

In the department of applied mathematics, which is under the charge of Dr. C. G. Knott, arrangements have been made for the inclusion of special honours courses on wave-motion in matter and æther, kinetic theory of gases, and radiation. The former courses on dynamics, hydrodynamics, and elasticity have also been extended, one of the full-year courses being specially adapted to the needs of the student of engineering. There is also a post-graduate course on quaternion vector analysis.

MR. J. S. W. BOYLE has been appointed lecturer and assistant in chemistry in University College, Dundee, in succession to Dr. J. K. Wood.

THE Right. Hon. Christopher Addison, Minister of Health, will deliver the introductory address at the opening of the winter session of the London (Royal Free Hospital) School of Medicine for Women, University of London, on Wednesday, October 1, at 3 p.m.

THE ninety-seventh session at Birkbeck College, Breams Buildings, London, E.C.4, will commence on Monday next, September 29. Courses, day and evening, in the faculties of arts, science, laws, and economics for the examinations of the University of London begin on the following Tuesday. Full details of the courses are given in the syllabus of the college, which can be obtained on application to the secretary.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 8.—M. Léon Guignard in the chair.—L. **Mangin**: Notice on the work of the late William Gilson Farlow.—G. **Humbert**: The measurement of the classes of Hermite of given discriminant in an imaginary quadratic body, and on certain non-Euclidean volumes.—G. **Bigourdan**: The work of La Caille (conclusion) and his successors at the Mazarin College.—M. **Stuyvaert**: The elimination of one unknown between three algebraic equations.—N. E. **Nörlund**: The principal solution of a certain equation of finite differences.—G. **Guillaumin**: The transversal effects of contraction in reinforced concrete structures.—P. **Chofardet**: Observations of Borrelly's comet (1919c) made with the *coudé* equatorial at the Observatory of Besançon. Observations, with positions of comparison stars, are given for August 25, 27, and 28. The comet is of the 10th magnitude, is round, about 2′ diameter, with a central condensation. There is no tail.—J. **Guillaume**: Observations of Borrelly's, Kopff's, and

[1] This view of the energy of a magnetic field, that it is direct kinetic energy of the æther moving longitudinally, suggests a possible (or nearly impossible) experimental means of determining the real density of the æther of space—a subject on which I have much more to say. See *Phil. Mag.* for May, 1919.

Metcalf's comets made with the *coudé* equatorial at the Observatory of Lyons. Observations of each comet were made on August 28.—G. **Sagnac**: The æther and the absolute mechanics of waves.—J. **Rey**: A lighthouse of great power, arranged with metallic mirrors. A description of the optical arrangements adopted at a lighthouse erected off the coast of Tunis. Metal reflectors only were used, without glass. Details of the photometric measurements and range are given.—Ch. **Maugain** and L. J. **Simon**: Cyanogen chloride. A review of the methods suggested for the preparation of cyanogen chloride, including three new electrolytic methods, based on the electrolysis of a mixture of hydrochloric and hydrocyanic acids. The pure liquid chloride solidified at −6·5° C., and boiled at 12·5° C. The only other cyanogen chloride is the solid polymer melting at 145° C.—Ch. **Pussenot**: New observations concerning a recent submersion of the coasts of Morbihan.—M. **Leriche**: The fossil fishes of the coast region of the Congo, and on the presence of the Eocene in this region.—L. **Blaringhem**: Vigour of growth, compensating sterility, in the hybrids of species of Digitalis (*Digitalis purpurea*: *D. lutea*). The hybrids between species of Digitalis are absolutely sterile, but there is an excessive development of the plant-tissues with all the characters of young, supernourished organs.—E. **Roubaud**: The antagonism of cattle and man in the blood nutrition of *Anopheles maculipennis*. The anti-paludic *rôle* of domestic cattle. When the mosquito has choice of man or domestic animals, it attacks the latter for preference. In order of preference, mosquitoes go first to pigs, then cattle and horses, then sheep, rabbits, and dogs. Fowls are not touched. When there are plenty of cattle adjacent to a house, the mosquito is not found in the house.—G. **Bertrand** and M. **Dassonville**: The treatment of scab in horses by the vapours of chloropicrin. Chloropicrin has been successfully applied to the cure of scab in horses; it possesses advantages over the sulphur dioxide treatment.

BOOKS RECEIVED.

Mind and its Disorders: A Text-book for Students and Practitioners of Medicine. By Dr. W. H. B. Stoddart. Third edition. (Lewis's Practical Series.) Pp. xx+580. (London: H. K. Lewis and Co., Ltd., 1919.) 18*s*. net.

An Elementary Course of Infinitesimal Calculus. By Prof. Horace Lamb. Third edition, revised. Pp. xiv+530. (Cambridge: At the University Press, 1919.) 20*s*. net.

The Study of the Weather. By E. H. Chapman. (The Cambridge Nature Study Series.) Pp. xii+131. (Cambridge: At the University Press, 1919.) 3*s*. 6*d*. net.

An Enquiry Concerning the Principles of Natural Knowledge. By Prof. A. N. Whitehead. Pp. xii+200. (Cambridge: At the University Press, 1919.) 12*s*. 6*d*. net.

Aeroplane Structures. By A. J. Sutton Pippard and Capt. J. Laurence Pritchard. With an introduction by L. Bairstow. Pp. xii+359+xxi plates. (London: Longmans, Green, and Co., 1919.) 21*s*. net.

The Natural History of South Africa. By F. W. Fitzsimons. Mammals. Vol. i., pp. xix+178. Vol. ii., pp. xi+195. (London: Longmans, Green, and Co., 1919.) 9*s*. each vol.

Principles of Electric Spark Ignition in Internal Combustion Engines. By J. D. Morgan. Pp. vii+88. (London: Crosby Lockwood and Son, 1920.) 8*s*. 6*d*. net.

Ireland: The Outpost. By Prof. G. A. J. Cole. Pp. 78. (London: Oxford University Press, Humphrey Milford, 1919.) 3*s*. 6*d*. net.

The Stanton Drew Stones. By E. Sibree. Pp. 20. (Bristol: J. W. Arrowsmith, Ltd., 1919.) 1*s*.

Geology of India for Students. By D. N. Wadia. Pp. xx+398+xx plates. (London: Macmillan and Co., Ltd., 1919.) 18*s*. net.

Mendelism. By Prof. R. C. Punnett. Fifth edition. Pp. xv+219+vii plates. (London: Macmillan and Co., Ltd., 1919.) 7*s*. 6*d*. net.

Proceedings of the Aristotelian Society. New series. Vol. xix. Containing the Papers read before the Society during the Fortieth Session, 1918–19. Pp. iii+311. (London: Williams and Norgate, 1919.) 20*s*. net.

Aristotelian Society. Supplementary vol. ii. Problems of Science and Philosophy. The Papers read at the Joint Session of the Aristotelian Society, the British Psychological Society, and the Mind Association, held at Bedford College, London, July 11–14, 1919. Pp. iii+220. (London: Williams and Norgate, 1919.) 12*s*. 6*d*. net.

Guide to the Study of the Ionic Valve: Showing its Development and Application to Wireless Telegraphy and Telephony. By W. D. Owen. Pp. vii+59. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 2*s*. 6*d*. net.

The Essentials of Chemical Physiology for the Use of Students. By Prof. W. D. Halliburton. Tenth edition. Pp. xi+324. (London: Longmans, Green, and Co., 1919.) 7*s*. 6*d*. net.

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